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ASSESSING THE SOCIAL IMPACTS OF OIL SPILLS PROCEEDINGS OF AN INVITATIONAL SYMPOSIUM CO-SPONSORED BY THE INSTITUTE ON MAN AND SCIENCE AND THE U.S. ENVIRONMENTAL PROTECTION AGENCY HELD AT RENSSELAERVILLE, NEW YORK ON SEPTEMBER 25-28, 1973

Environmental Protection Agency, Washington, D. C.

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September 25–28, 1973 **Rensselaerville, N.Y.**

116

ASSESSING THE SOCIAL IMPACTS OF OIL SPILLS

BACKGROUND PAPERS AND CONFERENCE PROCEEDINGS OF AN INVITATIONAL SYMPOSIUM

SPONSORED BY:

U.S. Environmental Protection Agency
The Institute on Man and Science

September 25—28, 1973
Rensselaerville, New York

PROJECT DIRECTOR:

Gordon A. Enk

THE INSTITUTE ON MAN AND SCIENCE

February 1974

PREFACE

Our society is in a developmental stage towards understanding and assessing the impacts of environmental perturbations. The initial efforts have focused on impacts in the biological realm. We have only recently begun to consider the effects that disturbances such as oil spills have on the human community. Assessing social impacts is an area of great interest and concern, but not one of established methodologies and expertise.

This report presents the results of an invitational symposium held to encourage the development of techniques and methodologies in the Assessment of the Social Impacts of Oil Spills. The symposium, cosponsored by The Institute on Man and Science and the United States Environmental Protection Agency, was held September 25-28, 1973, at The Institute's campus in Rensselaerville, New York. Sixty-three representatives of government, industry, the academic community, and environmental interest groups attended. The participants ranged from local citizens' group activists to national and international authorities on various aspects of the subject.

The report, like the program it represents, is multifaceted. To facilitate reference and readability, it is divided into topic areas which correspond to the individual session themes. Presentations by core faculty members have been summarized rather than transcribed. In addition, a brief narrative account of each session introduces the faculty presentations. These narrative sections describe the kinds of questions raised by the participants, delineate the major points of debate and discussion, and summarize the group response to the two learning exercises, posed as task team assignments, that were incorporated within the program's format.

Another significant inclusion appears in Appendix A. Three informal papers were prepared by participants during the symposium. These papers cover several relevant areas of interest that, due to time limitations, were not discussed at length during formal program sessions. Appendix B contains preconference research on the legal and ecological impacts of oil spills. These reports were prepared by Institute research assistants Thomas R. Lundquist and Emily C. Weller for use as pre-conference readings.

The main goal of the symposium was to initiate a dialogue between environmentalists, corporate executives, government representatives, and scientists. The formal sessions and task team exercises actualized that goal for the participants. The report, which reflects the nature of this colloquy, will hopefully act as an impetus for moving beyond words to action.

Finally, a special word of thanks must be given to Royal Nadeau and Steve Dorrler of the U.S. Environmental Protection Agency. Their thoughts and guidance played a key role in the conference. A debt of gratitude is also owed to Marian Baumgold, who prepared the narrative sections and edited much of this publication, and to Lucille Kropp and Jeanette Lendrum whose patience in typing the manuscript is appreciated.

Gordon A. Enk
Rensselaerville, N.Y.

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CONTENTS

I. THE OIL SPILL PERSPECTIVE

Introduction 1

Oil Spills: Causes, Quantities, Sources — The Magnitude of the Problem — *Joseph D. Porricelli* 3

The Future Directions of Assessments of Impacts — *Harold Snyder* 7

II. EPA'S RESPONSE TO OIL SPILLS

Introduction 9

Assessment of Environmental Damages Following an Oil Spill — A Prospectus *Royal Nadeau* 11

The True Economics of Oil Spill Cleanups: What Do We Get For Each Dollar? — *J. Stephen Dorrler* 15

III. THE LEGAL RESPONSE

Introduction 17

The Role of the State in Damage Assessment — Tennessee, A Case Study — *Bobby L. Stratton* 19

Must the People Suffer — Should Legislation Be Enacted to Provide a Means to Compensate Persons Damaged by the Discharge of Oil From Vessels on the Navigable Waters of the United States? — *Thomas R. Post* 21

Private Damages From Oil Spills in a Marine Environment — *Joseph C. Sweeney* 27

Task Team Session #1 35

IV. THE CORPORATE RESPONSE

Introduction 39

The Oil Company's Position in an Oil Spill *L. P. Haxby* 41

Role of the Oil Spill Claims Adjuster — The Middleman *Ron DeNoville* 43

V. SYSTEMS, ECONOMICS, AND POLITICAL SCIENCE APPROACHES

Introduction 47

The Application of Systems Analysis Techniques to Social Impacts Due to Oil Spilled in the Marine Environment *Joseph Pizzo* 49

Economic Damages From Oil Spills: Measurement Techniques and Empirical Results *Dennis P. Tihansky* 57

Methodological and Political Problems Involved in Evaluating Social Action Policy *Thomas J. Cook and Frank P. Scioli, Jr.* 67

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VI. PUBLIC INTEREST GROUPS AND OIL SPILLS

Introduction . . . 71

Role of Environmental Organizations in Clarifying Social Impacts of Oil Spills and Oil Pollution
Brock Evans . . . 73

The Coastal Zone and Oil Spills: Cultural Splits
Wesley Marx . . . 77

VII. DIRECTIONS AND PRIORITIES

Introduction . . . 79

Considerations on the Governmental Responses to Environmental Crisis or Disaster
Bert Swanson . . . 81

Task Team Session #2 . . . 83

APPENDIX A:

Incremental Benefits and Costs of Compulsory Segregated Ballasting Reducing Oil Pollution of the Sea
by Hang-Sheng Cheng . . . 89

The Energy Crisis: How to Survive Until We Run Out of Oil
by Norman K. Sanders . . . 97

International Activity Responding to Oil Pollution Damage From Vessels at Sea
by Thomas S. Busha . . . 101

APPENDIX B:

Compensation for Oil Pollution Damages
by Thomas R. Lundquist . . . 107

Oil: Its Properties and Environmental Effects
by Emily C. Weller . . . 115

SUGGESTED READINGS . . . 121

LIST OF PARTICIPANTS . . . 127

I. THE OIL SPILL PERSPECTIVE

INTRODUCTION

Gordon Enk, Director of Economic and Environmental Studies for The Institute on Man and Science and the program coordinator, introduced the four-day symposium as an opportunity to both exchange ideas and initiate a dialogue. During his opening remarks, he suggested that the participants themselves would create the focus on the problem of assessing the social impacts of oil spills. The Institute had invited a core faculty who had examined various aspects of the problem. Formal presentations describing current methods for assessment, analyzing their weaknesses and strengths, and prescribing new, useful methodologies would be delivered by these individuals. Ecological, social, legal, and economic frameworks would be provided, but the participants were informed that they themselves would develop the common thread, the necessary perspective. The group would be asked to decide upon a viable approach for assessing all the damages society suffers by the accidental discharge of oil into the environment.

The participants were assigned to task teams which met several times during the program. The task team approach of dividing up into small, informal discussion groups allowed an interchange of information among the represented disciplines. To guarantee a diversity of opinions and expertise within the task teams, participants were divided into teams on a "maxi-mix" basis. The two tasks developed by The Institute were structured to:

1) delineate the common ground among the participants on the need for research into the social and ecological impacts of oil spills, and
2) design specific directives and goals for this research.

It was hoped that the combination of faculty input and task team discussion would move the participants' comprehension of the problem beyond the information gathering stage. The symposium's opening session established the goal for the participants' role in the program: comprehend the state of the art of the various methodological approaches and determine how these approaches could be synthesized into a viable assessment program.

Comprehension of the scope and degree of the problem began with the symposium's first speaker, Joseph Porricelli of Engineering Computer Opteconomics, Inc. He cited the current sources of oil pollution in the marine environment and discussed at length the role of tankers in ocean pollution. Technical means for reducing the probability of oil spillage from tankers, including segregated ballasting, double-side, double-bottom design, and traffic control systems were suggested. The presentation included statistical data on the frequency and nature of tanker accidents. In conclusion, he stated that the technology exists to reduce the amount of oil spilled into the marine environment and that this technology should be implemented.

Harold Snyder, of the U.S. Environmental Protection Agency (EPA), then described some of the current procedures used for the immediate assessment of damages from an oil spill. But, he pointed out, his role in the symposium as a representative of the federal agency most actively involved in damage assessment was not to provide information as much as to listen. He posed several questions for the participants to try to answer during the ensuing days:

1) Who really cares about oil spill impact assessment?
2) Who would this audience want to hear from (the federal government, the universities, an independent research body)?
3) When do they want to hear about the damages (immediately after a spill, during a spill, several months later)?
4) Through which medium of communication do they want to hear about the damages (newspapers, television, scholarly articles, film strips)?

He concluded by stating that the EPA wanted the participants' inputs and was, itself, investigating ways to improve its assessment processes.

OIL SPILLS: CAUSES, QUANTITIES, SOURCES – THE MAGNITUDE OF THE PROBLEM

JOSEPH D. PORRICELLI
Senior Vice President,
Engineering Computer Opteconomics, Inc.

To give a meaningful evaluation of the merits of the various measures of mitigating oil spillage, one must first have accurate data on the sources and magnitude of oil entering the ocean ecosystem. There is an approximate total of five million metric tons of oil spilled in the ocean each year. Of this, about 50% is of non-marine origin, including sources such as refineries and petro-chemical plants, industrial machinery, and motor vehicles. Motor vehicles account for a major proportion of the oil pollution of non-marine origin as shown in Figure 1. Most of the oil used in motor vehicles is disposed of directly into sewer systems or directly into the earth. The total annual oil pollution of motor vehicle origin adds up to approximately 1.47 million metric tons, or 29.4% of the oil from non-marine sources, and is the single largest source of oil pollution of the oceans. The second most abundant source of oil pollution of the oceans is from tankers. Tankers account for 28.4% of the oil pollution of the oceans, or a total of approximately 1.42 million metric tons per year.

Since 42% of the energy consumed depends on oil, and since by 1985 approximately 52% of U.S. oil demand will be imported, the problem of tanker-caused oil pollution is and will continue to be of great importance. This problem is reflected in Figure 2. In 1970, there were 1,300 million tons of oil transported at sea, and it is expected that this will double by the end of the decade.

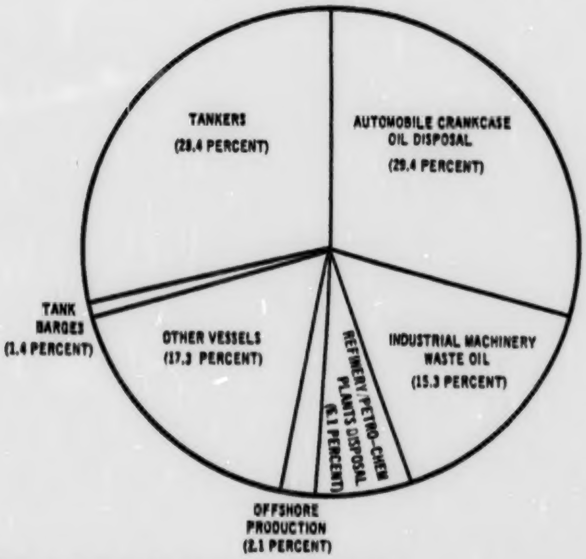

*Figure 1. Sources of oil pollution to the oceans.**

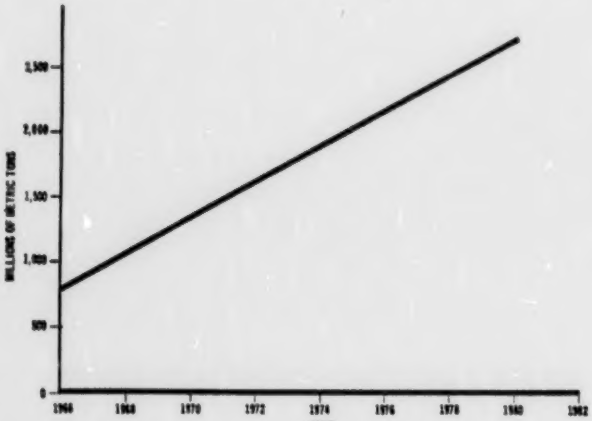

*Figure 2. Oil transported at sea annually.**

Oil pollution emanating from tankers enters the marine environment from a variety of sources. The pollution may be due either to casualties or to operational causes. Figure 3 shows that casualties, the most

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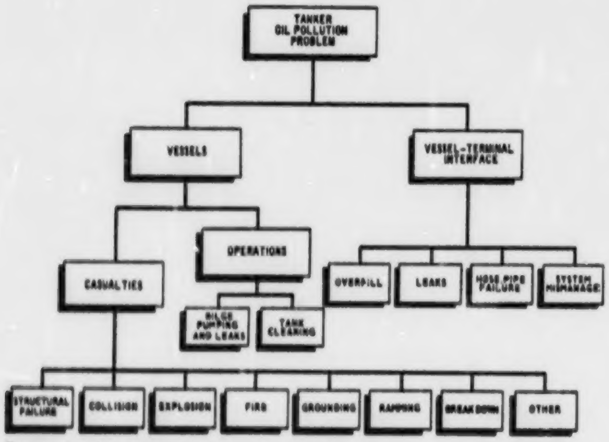

Figure 3. The tanker oil pollution problem. *

spectacular source of tanker-caused pollution, are caused by structural failure, collision, explosion, fire, grounding, ramming, or breakdown. Figures 4a and 4b show that in 1969-1970, there were at least 1,416 tanker casualties which resulted in 169 polluting incidents. These are minimum estimates, as no standard world-wide reporting system is actually in operation.

Generally, when tanker accidents are analyzed according to tanker size, there is no clear-cut indication that large tankers are safer than smaller tankers or vice versa. This is partly due to the fact that the large ships are mainly used for long haul operations; thus they do not travel in and out of ports as frequently as their smaller counterparts. In the United States there are only a limited number of deep water ports such as Seattle, Washington; Eastport, Maine, or Long Beach, California.

The smaller tankers have a higher frequency of moving in and out of ports on short-haul operations, and thus their probability of being involved in a collision, grounding, or ramming goes up significantly. The advent of traffic control systems in some harbors, however, has reduced the incidence of accidents. Looking at Figures 5 and 6, we can see that in 1969-1970, 22.4% of the collisions occurred within the coastal zone, and 64% occurred near the entrance to or within a harbor. Of the groundings, 16.1% occurred within the coastal zones, and 75.1% occurred near the entrance to or within a harbor. The Ports and Waterways Safety Act of 1972, which in Title I requires that traffic control systems be developed in large ports, will reduce the risk of casualties in high traffic density areas. This has been fairly well illustrated for San Francisco Bay which, upon the installation of a traffic control system, has had no incidents. Since most accidents occur in the biologically sensitive coastal and harbor areas, this method of pollution control is very important. Other methods such as increased maneuverability, the development of collision avoidance devices, and improved personnel training can also aid in avoiding accidents.

The development of offshore terminals has also been suggested as a viable method of accident control. The oil must still be brought to shore, however, and the accident frequency would not necessarily be reduced by just unloading large ships at offshore terminals to smaller tankers which must still travel into the harbors. The more viable option of using a buried underwater pipeline would appear to be justified in conjunction with a monobuoy array.

Returning to Figure 3, it can be seen that casualties are not the only source of pollution when vessels are at sea. Figure 7 shows that operational procedures are another source and actually account for a much larger percentage of oil pollution.

Most operationally-caused oil pollution originates in the deballasting and tank cleaning procedures used by the tanker operators. Tanks, for a number of reasons, must be cleaned periodically and ballast

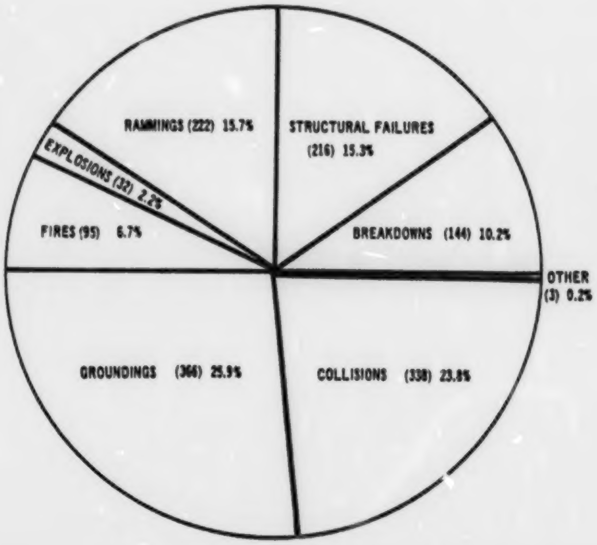

Figure 4a. Type, number and percentage of the 1416 tanker casualties which occurred during 1969 and 1970. *

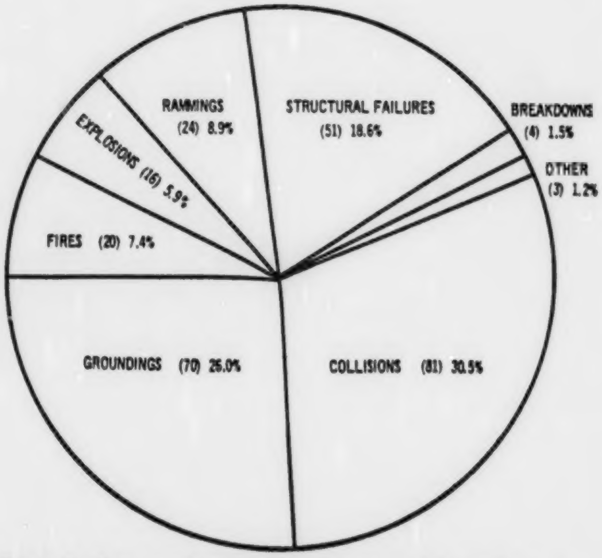

Figure 4b. Type, number and percentage of the 266 polluting incidents resulting from tanker casualties which occurred during 1969 and 1970. *

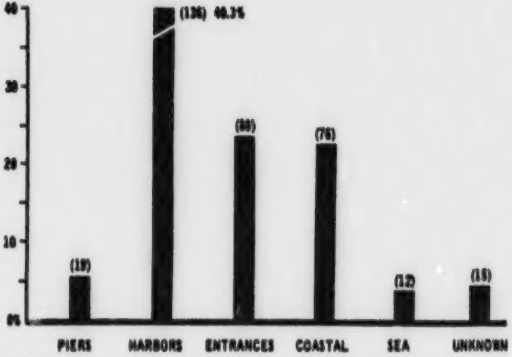

Figure 5. Percent of tanker casualties from collisions. *

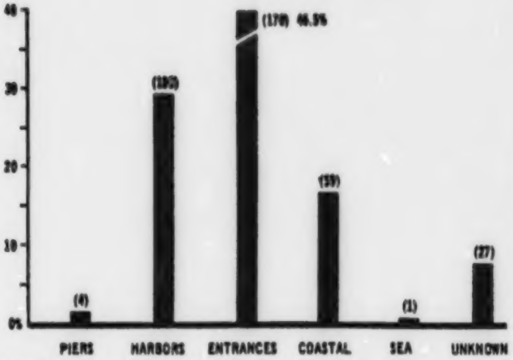

Figure 6. Percent of tanker casualties from groundings. *

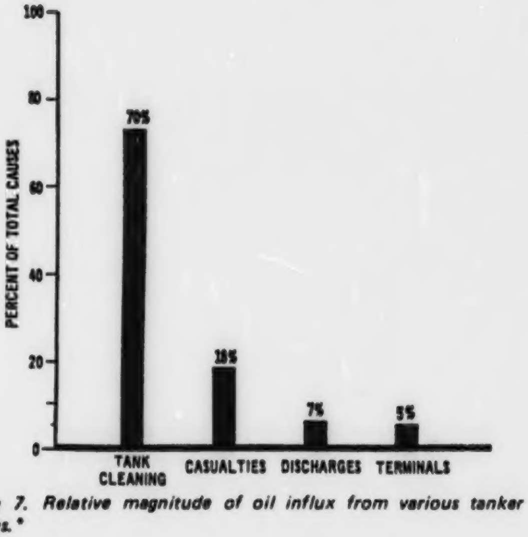

Figure 7. Relative magnitude of oil influx from various tanker sources. *

water must be routinely taken aboard for ship safety and controllability. These two procedures account for the large percentage that operational procedures contribute to oil pollution.

A number of national laws and international treaties now require that tankers release their oily wastes at sea rather than in port. The total pollution of the sea, however, does not change by regulating only the location of discharge. In fact, if all tankers released their oily ballast uncontrolled, the one million tons released annually would increase to something on the order of five million tons.

There are several methods of controlling the ballast problem. The first of these is called the load-on-top method. Since oil generally floats to the top, the water is decanted off the bottom and the residue oil pumped to a separate tank for combination with the next cargo. This method has an 80 to 90 per cent efficiency, depending on the equipment provided and on the expertise of the tanker operator. In any case, this is a man-dependent operation and in that lies its efficiency and reliability.

Another method is to use a segregated ballast system whereby certain tanks are used exclusively for salt water ballast. The most effective design for a segregated ballast system is the double-bottom system as shown in Figure 8. In this design, two causes of oil pollution can be solved simultaneously by one design: the operational problem of ballasting and the accident problem due to groundings which, excluding massive structural failures, is the single largest source of oil pollution due to tanker accidents (see Figure 9). If a ship runs aground when filled with oil, the double bottom will very often protect the inner oil tank from rupture and from releasing its contents. Some criticisms of this method have been that there might be some leakage of flammable gases into the empty double-bottom tank which could cause a catastrophic situation due to explosion and fire. This criticism has simply not been borne out by fact. Combination carriers (OBO's) have operated this way for years.

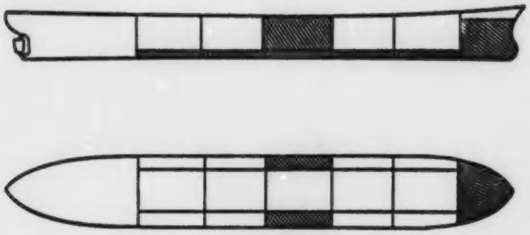

Figure 8. Arrangement of VLCC with double-bottom, wing and forepeak ballast tankers. *

Figure 10 depicts another method for segregated ballasting: the use of flexible membranes which are impervious to both oil and salt water. The membranes would be attached to both sides of a floating barrier which would be depressed against the bottom of the tank when the tanker is filled with oil, but which could be raised to form an expanding compartment when the tank is used for salt water ballast. This design has an advantage in that a single tank can serve as both a cargo and a ballast tank without mixing oil and water.

At the moment, however, this concept has not been fully developed. In all cases, however, shore reception facilities for oily residues will be required in order to reduce the amount of oil pollution. These shore reception facilities must have an effective, nonpolluting method to dispose of residue oil.

In conclusion, the magnitude of oil pollution can be greatly reduced by the technological procedures just discussed. The input of oil into the marine ecosystem due to operational procedures can be greatly reduced by the use of segregated ballast. The double-bottom design is the most promising method since it could also eliminate about 70 per cent of the oil pollution resulting from groundings. The input of oil into the marine environment due to casualties can also be reduced by better technology. Increased maneuverability of ships and the development of collision avoidance devices, along with better personnel training and strict harbor traffic controls, can aid in this direction.

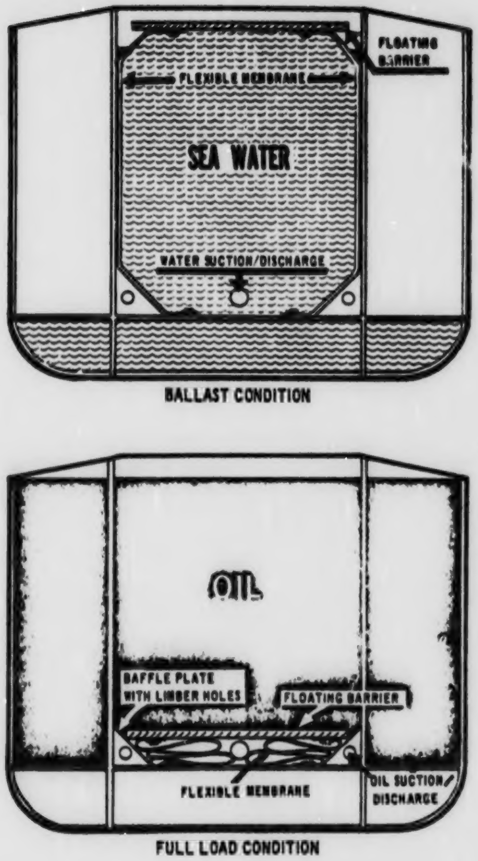
FLOATING BARRIER
FLEXIBLE MEMBRANE
SEA WATER
WATER SUCTION/DISCHARGE
BALLAST CONDITION
OIL
BAFFLE PLATE WITH LIMBER HOLES
FLOATING BARRIER
FLEXIBLE MEMBRANE
OIL SUCTION/ DISCHARGE
FULL LOAD CONDITION

Figure 10. Flexible membranes. *

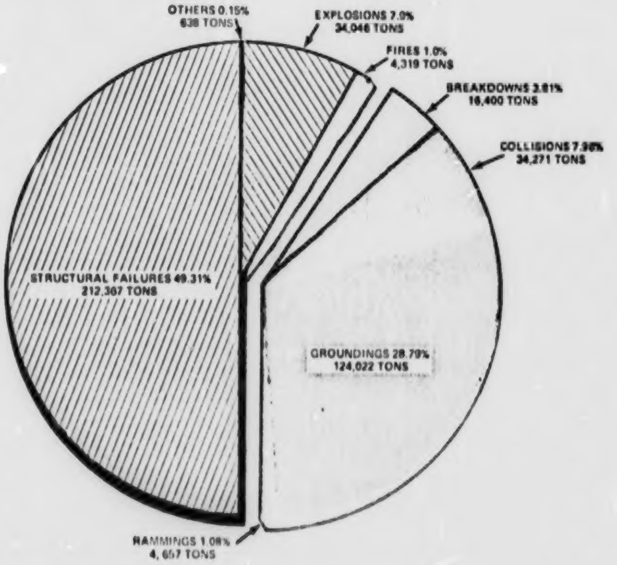

Figure 9. 1969-1970 polluting incidents and 430,720 long tons of outflow-magnitude distribution. **

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*These figures are from the paper "Tankers and Ecology" by Joseph D. Porricelli, Virgil F. Keith, and Richard L. Storch, published in 1971 TRANSACTIONS of the Society of Naval Architects and Marine Engineers and included herein by permission of the above-mentioned Society.

**This figure is from Joseph D. Porricelli and Virgil F. Keith. An Analysis of Oil Outflows Due to Tanker Accidents. Presented to the 1973 Conference on the Prevention and Control of Oil Spills. U.S. Coast Guard Headquarters, Washington, D.C., March 1973.

THE FUTURE DIRECTIONS OF ASSESSMENTS OF IMPACTS

HAROLD SNYDER
Oil Spill Branch,
Division of Oil and Hazardous Materials,
Environmental Protection Agency

Before discussing future directions for the assessment of oil spill impacts, let me provide you with a brief history of the organization I represent, the Division of Oil and Hazardous Materials within the EPA. Before becoming incorporated within the EPA structure, the Division of Oil and Hazardous Materials functioned within the Department of the Interior. The emphasis of our division is to insure prompt and adequate response to spill incidents so that adequate cleanup and mitigative efforts are conducted. It is also our responsibility to set environmental priorities so that cleanup resources can be allocated to the most valuable environmental resources. Setting enforcement penalties and taking legal punitive measures is the responsibility of EPA and U.S. Coast Guard enforcement units. We have also assumed the task of analysis and evaluation of the effects of such incidents on the environment.

To carry out our mission of damage response to a spill incident, we use basic ordering agreement contractors (BOA's). Briefly, the use of outside contractors, with pre-negotiated contracts, has enabled us to respond as rapidly as possible to a spill incident. Although this particular aspect of EPA's response to damage assessment warrants further discussion, let me provide you with a brief history of our use of this mechanism before discussing the significant questions of what we should be doing and how best to do it.

The idea of BOA's began when intra-agency discussion was initiated on how to best study the phenomenon of floating tarballs. This occurred during the time that Oil and Hazardous Materials was within the Department of the Interior. It was decided that rather than conducting the investigation as research, we should investigate it as an operational exercise. We sought contractors using pre-negotiated, stand-by contracts and thereby established a mechanism for the rapid investigation of whatever questions we were asked to examine. The first big test of this method of response came after the Shell Platform Fire of December 1970. Our evaluation of this incident, using the BOA approach, set the stage for critical examinations and discussions of this mechanism. It should be stressed, however, that the combined effort of EPA and its outside contractors contributed to a significant assemblage of information on the incident.

Damage assessment was also conducted for the 1971 spill of No. 2 Fuel Oil in Puget Sound. Although this report is currently unavailable for public dissemination due to its use in legal proceedings, we have a "classic" damage assessment effort that we undertook on a spill incident in Long Island Sound, off New London, Conn. (Spring 1972), which will be released soon. There have been similar important investigations in the Casco Bay spill, Portland Harbor, Maine (Summer 1972), and in the Schuylkill River spill in Pennsylvania that was caused by Hurricane Agnes (Spring 1972). Although our investigation of the L.I. Sound spill was primarily a biological investigation, our investigation of the Portland Harbor spill contains an assessment of the cleanup techniques used and physical effects on the shoreline. The distinguishing feature of the Schuylkill spill was the fact that by using the BOA system we were able to obtain immediate advice on which way to handle the pressing cleanup problems the U.S. government was engaged in and the related health hazards. We have aspired to do the best job possible on the spills we have assessed, but we cannot deny that more money and a longer period of time to assess the area affected by the spill would be helpful.

What might help us the most at the moment, however, would be to learn your response to the role of the EPA in damage assessment. Although I am not saying that EPA will automatically switch over from its biological emphasis to a social emphasis in its assessment process, I *am* saying that *we do want to arrive at a better understanding of what can be done and how strong the demand is for us doing it.* I hope I have given you some idea of the kinds of things we do. Our assessment process, so far, has been a biological, scientific, quasi-research effort. The essential questions for you to answer during this symposium concern the kinds of new directions we should take. Perhaps the most important question I can ask you is, "Who really cares about oil spill effects?" Is it the general public, the fisheries interest, the oil industry, the adversaries of the oil industry, government policymakers, local governments?

A second significant question is "Who do they wish to hear from?" Is EPA an acceptable source or would an impartial academic institution be a more credible authority? Getting back to the question of BOA's, do the people who care about assessment efforts want EPA as the sole investigator or do they favor the use of independent contractors? Specifically, how do you react to a statement like this, found in the beginning of an EPA report:

> **EPA Review Notice**
>
> This report has been reviewed by the Office of Water Programs, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Besides determining how strong the voice of EPA should be, we need to find answers to other questions. Just how much do people want to know? If we publish data on biological damage, would our readers be interested in the entire food-web or simply the edible, economically identifiable species? How extensive a coverage of physical damages is wanted? Shall we include boats, piers, beaches, shoreline? In our assessment of recreational damage, shall we include bathing, fishing and aesthetic damages? What is the level of interest in human health hazards? Are people interested in the degree and rate of recovery over time? Should we emphasize lessons to be learned to guide in the prevention of future incidents?

Another significant area of interest for us concerns the time frame of our assessments. When does the public want to know about oil spill damages: during the event, at a reasonable later time which would allow for accurate reporting, after the recovery is known? Does an undue delay in publishing our findings dull interest or harm our credibility? Along these lines, we can also ask what the proper forum of communication should be: the news media, general periodicals, scientific periodicals, EPA reports, or promotional aids such as movies or film strips?

As you can see, what we really need is a forum of input into EPA. I am here to seek information from you and to receive your suggestions. Although the emphasis of this symposium is on the *social* impact of oil spills, the term "social" is a broad one and the kind of work EPA has done, the effects of oil on organisms, for example, is "social" in a very real sense. With your guidance, we may be able to expand our efforts to more closely fit the breadth of "social."

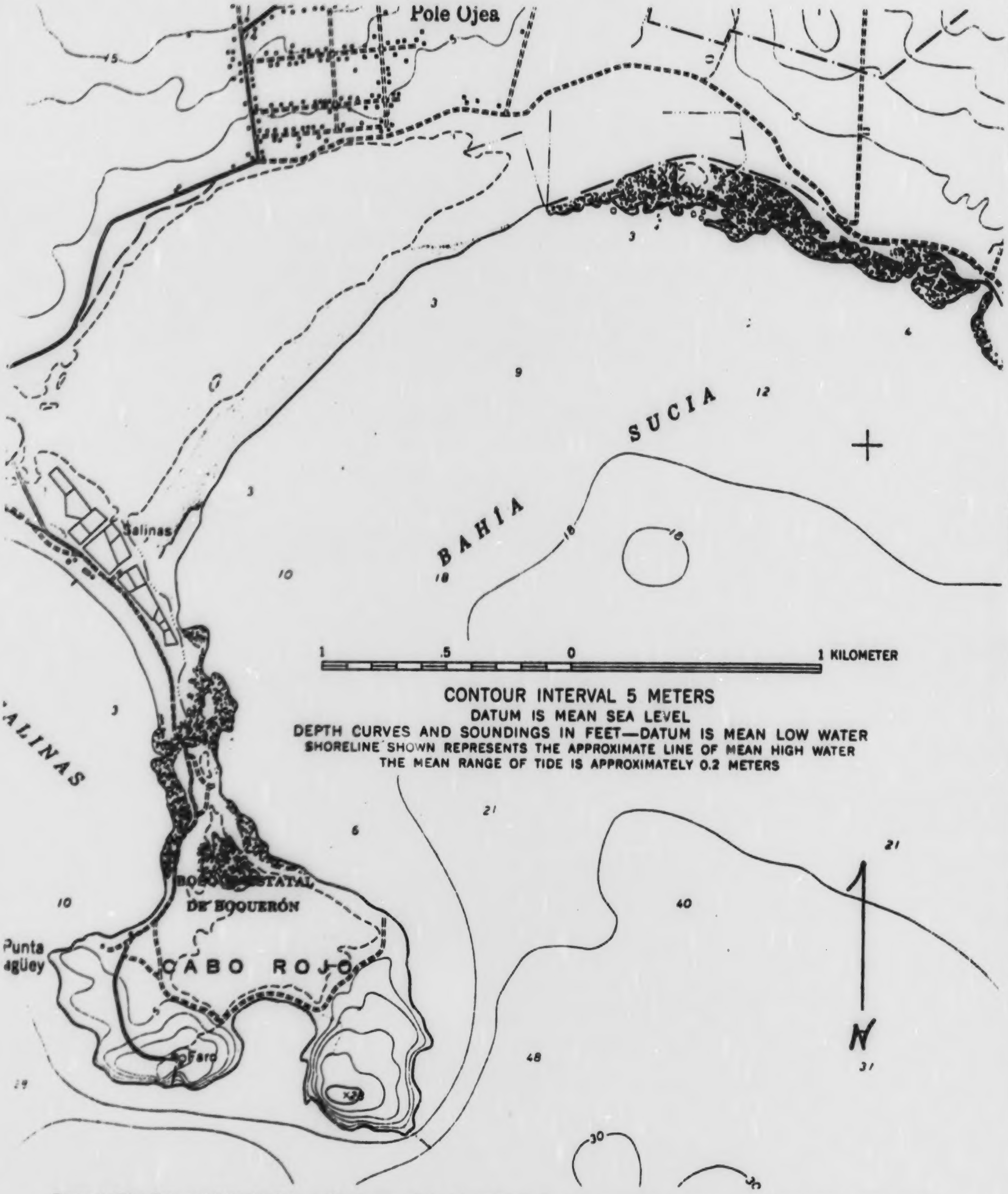
II. EPA'S RESPONSE TO OIL SPILLS

INTRODUCTION

The second session moved the symposium from a general overview of the oil pollution problem to a description of the primary method currently used to assess oil pollution damage — the Environmental Protection Agency's biological assessment of oil spill impacts.

Royal Nadeau, of the EPA's Industrial Waste Treatment Laboratory, described the biological assessment that EPA conducts following an oil spill. Immediately after a spill has occurred, EPA biologists are on the scene to assess the damage with their "calibrated eyeballs." Once more equipment and manpower arrive, local biologists are sought out, since their knowledge of the spill-affected area can be quite useful in directing cleanup and mitigative efforts; samples of impacted biota are taken for chemical analysis, and photo-documentation of the affected area is undertaken. He illustrated the EPA procedures through a case study of the March 1973 Cabo Rojo (Puerto Rico) oil spill.

Stephen Dorrler, also of the Edison Lab, discussed the coordination of the biological damage assessment. Outside contractors holding pre-negotiated, basic ordering agreements (BOA's) with the EPA are generally used to insure rapid cleanup operations (when the spiller does not opt to remove the oil or when the spiller is unknown) and quantitative biological damage assessment. The extent of these cleanup and assessment operations is determined by the on-scene coordinator (OSC). The OSC operates within the guidelines of the National Contingency Plan which outlines procedures for post-spill cleanup. Dorrler also raised the problem of assessing biological damage in economic terms. While we know the cost of oil cleanup ($.50 — $14 a gallon), it is difficult to determine the value of a damaged microscopic organism or a damaged beach. The true costs of oil spill damages, he maintained, cannot be successfully determined until we have more comprehensive standards of damage assessment.


Pole Ojea
Salinas
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ALINAS
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CABO ROJO
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1 .5 0 1 KILOMETER
CONTOUR INTERVAL 5 METERS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.2 METERS
N

Figure 1. Cabo Rojo and Bahia Sucia in southwest apex of the Isle of Puerto Rico. Oil extended around the front of the Cabo to the northern mangrove swamps on the mainland.

ASSESSMENT OF ENVIRONMENTAL DAMAGES FOLLOWING AN OIL SPILL — A PROSPECTUS

ROYAL NADEAU

Aquatic Biologist, Oil Spill Research Branch,
Industrial Waste Treatment Research Laboratory,
EPA, Edison, New Jersey

I would like to give a specific case to illustrate the procedures I have outlined here. The case in point is one I was involved in which took place on March 16, 1973, on the southwest corner of the island of Puerto Rico — the Cabo Rojo spill. Cabo Rojo is a sandy barrier beach that juts out into the Caribbean Sea approximately two and a half miles from the mainland. A map of this region appears as Figure 1. This spill was not publicized much in the States, but certainly was in the Puerto Rican newspapers. My personal involvement began with a phone call a few minutes before midnight on a Sunday evening. I was told to be ready for a seven o'clock flight the next morning to Puerto Rico. I had no idea how long I was to stay, or exactly where the spill was located. The only information I had at the time was that a marine biologist was needed to assess the impact. The spill had occurred near an area of national interest called Bahia Fosforesiente. This bay was unique in that the water, during certain times of the year and under certain environmental conditions, would exhibit bioluminescence with a little perturbation. There was obviously a great deal of concern that the oil might make its way into this bay.

The Cabo Rojo spill took place at night when a Greek tanker ran aground on a sand bar. The captain, who later claimed that his navigational aids had failed him, decided that the only way to save his ship was to dump its cargo. First, he pumped his fresh water supply and then his cargo, which amounted to about two million gallons of Venezualian crude oil. About 1.2 million gallons came ashore on Cabo Rojo and .8 million went to sea. Unfortunately for the captain of the ship, his radio communications were monitored by a local ham radio operator who notified the police. The police, in turn, notified the Coast Guard who made an overflight. The captain, upon reaching port, was arrested by a federal marshal for failure to notify within 24 hours, and his ship was impounded. Eventually, the captain was fined $6,000 and given a six-month suspended jail sentence. This was the first case under the new Federal Water Pollution Control Act in which the person responsible was charged with a criminal offense.

The spill itself took place near a mangrove swamp, a very unique ecological area, which is shown in Figure 2. The oil collected in Bahia Sucia ("Dirty Bay") which is so named because of the large amount of flotsam and jetsam which blows into the bay.

Generally, the biological effects of an oil spill can take several forms. There may be a direct kill of adult forms due to:

- coating causing asphyxiation
- contact poisoning
- exposure to water-soluble toxic compounds.

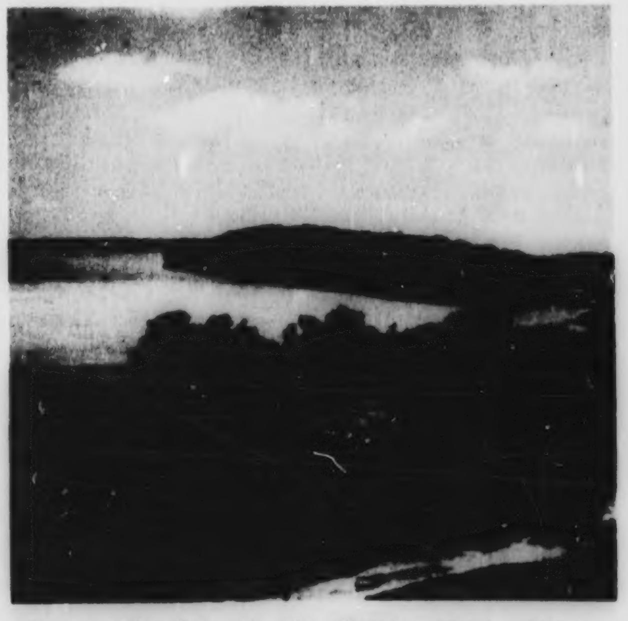

Figure 2. Cabo Rojo spill with affected mangrove swamp in foreground.

I would like to present a brief outline of the activities that take place after a typical oil spill. The actual timing in which each activity is performed may vary, but the general procedure is the same. First, there is the spill itself, which leads to some type of pollution, usually water. This is evidenced by certain biological or ecological effects or impacts.

The first job of the EPA comes in here — that is, to delineate what forms of life have been affected or impacted by the oil. It must be quickly determined if the avian, intertidal and planktonic, sublittoral or benthic species have been affected. These early determinations are made in the preliminary survey by the first people who arrive at the scene. The preliminary survey is a very critical stage in the assessment of environmental damages. If the first on-scene investigators do not "get a handle" on the situation at this early stage, they may never be able to effectively and accurately carry on the rest of the assessment procedures. The first investigators at the scene may not have the sophisticated equipment or the time available to do any in-depth surveys during this preliminary stage. They must rely on their "calibrated eyeballs," their experience and expertise, to make a quick overview of the spill situation.

After the preliminary survey is completed, a decision is made at a conference with the on-scene coordinator whether to call for additional help to make in-depth biological and chemical studies. The decision is made to call in extra help if it has been determined that the magnitude of the spill is excessive or if there is a unique situation at hand. Indeed, most spills are unique; there may be a situation in which an endangered species is being threatened or a new type of ecosystem not previously studied is being involved, which would warrant the call for additional manpower. This call goes out to the BOA's, the contractors who hold basic ordering agreement contracts with the EPA to perform the required studies. The contractors have shown that they have the expertise, in the form of biologists, chemists, oceanographers and equipment, to do an in-depth study of the impacts of an oil spill. They stand ready to come to the scene of an oil spill within a 24-hour period after notification. There are presently BOA's organized by region so that the entire U.S., Puerto Rico and Virgin Islands are covered in the event of a spill regardless of the location.

We have now reached the stage where the actual damage documentation takes place. This is done in three different ways. First, local witnesses are consulted. Very often we rely on the expertise of local biologists who are familiar with and, hopefully, may have done some collecting in the area. If there is any base line data available, we try to use it. Second, we rely to a great extent on photo-documentation. We acknowledge that the human mind has many inadequacies — the major of which is the tendency to forget the little details. For this reason, we stress photo-documentation of the visible effects of the spill. Third, we do field and laboratory studies to determine the not-so-visible effects of the spill. Of course, it is impossible to assess accurately the damage caused if the amount of oil present in the ecosystem is not known. Therefore, we try to quantify the actual amount of oil present to lend statistical credibility to the rest of our survey procedures.

There may also be destruction of the more sensitive larval forms. Many benthic organisms may not be affected in their adult stages by floating oil, but their pelagic larvae may certainly be imperiled. A species may be affected indirectly by the destruction of its food sources or by the incorporation of sublethal amounts of oil resulting in reduced resistance to infection and stress.

It is also possible for sublethal amounts of toxic materials to become trapped in the benthos and then recycle through the food chain long after the spill takes place. Evidence of this phenomenon was shown in the Falmouth spill where the spilled oil has been incorporated into the sublittoral and salt marsh sediments.

Biological damage in a specific area may be dependent on several factors including:

- — quantity and volume of oil spilled
- — hydrography of the area
- — climatic and seasonal changes
- — indigenous biota
- — treatment methods
- — previous exposure of the area to oil pollution.

The actual damage resulting from the Cabo Rojo spill was seen in several areas of the bay. The offshore turtle grass beds grow just below the intertidal areas. Within two days, however, much of the turtle grass was covered with oil from the surf and wind activity over the beds. The contaminated leaves and stems were removed during the cleanup operations. Six weeks later, sediment erosion had occurred since the beds anchor sand and sediment in much the same way as dune grasses.

The white-spined sea urchin shown in Figure 3, which lives in the turtle grass beds, suffered severe mortality. Mortality was not immediately observable, however. It took almost 48 hours before partially decomposed tests (the exoskeleton of the sea urchin) were found. Figure 4 shows that cancroid crabs, prawns, sipunculid worms, annelids and mollusks also suffered mortality. The black-spined sea urchin, which originally was affected, began to migrate back into the area after about two weeks. It could not be ascertained whether these affected organisms died from direct contact or from dissolved or dispersed contaminants in the oil.

On the seaward side of the mangrove swamps are the small micro-ecosystems which develop around the air roots of the mangrove trees. The air roots grow from the branches down into the water, trapping sand and debris and eventually forming new land. The mangrove swamps slowly advance seaward until they reach equilibrium with the sea. This is a very dynamic process. The small crustaceans, oysters, epiphtyes, and associated organisms growing on and around the air roots were severely affected by the oil. The mangrove trees themselves were not killed; at least no

Figure 3. White-spined sea urchin, a common inhabitant of Thallasia beds, was a species affected by the Cabo Rojo spill.

visible deterioration was evident six weeks following the spill.

Behind the mangrove swamps is a flat, muddy area which would be called by some, "a biological desert." Upon closer inspection, however, it is clear that this area teems with life, with a tremendous population of fiddler crabs and other small crustaceans. These were also severely affected by the oil.

The rocky shoreline at the edge of the bay was also contaminated. The surf and wind pushed the oil up considerably above the eight-inch tide mark. The pervading onshore winds forced the oil against the eastern shoreline of Cabo Rojo, facilitating an efficient cleanup. But this forced continuous exposure of the affected biotic communities to the oil.

There was no real fish kill in the area, although three or four local fishermen reported that there were dead fish and lobsters in their traps. Fishing in this area is purely a subsistence industry; the traps are made of mangrove roots. Since there is no legal aid society and since the fishing is in such a primitive state, with little economics involved, the affected fishermen have not been awarded any damages.

There was no heavy bird mortality due to this spill. Only one brown pelican was found dead. Most of the effects of the spill described here were observed during the preliminary survey. The results of the actual damage assessment program performed by the BOA have not yet been completely tabulated. A final report will be issued as soon as the data has been analyzed. This report will document the immediate effects and those occurring within six months following the spill.

Figure 4. Cancroid crabs and prawns were among those organisms affected by the Cabo Rojo spill.

THE TRUE ECONOMICS OF OIL SPILL CLEANUPS: WHAT DO WE GET FOR EACH DOLLAR?

J. STEPHEN DORRLER

Acting Chief, Oil Spill Research Branch,
Industrial Waste Treatment Research Laboratory,
EPA, Edison, New Jersey

The Environmental Protection Agency functions in the area of oil spills in two specific ways: it has operational responsibility in terms of spill prevention and cleanup, and it conducts research involving hardware development, chemical characteristics, and damage assessment. For the operational responsibilities, EPA is divided into ten regional offices throughout the United States. Each region has a method of oil spill response, including an on-scene coordinator, predesignated and with direct responsibilities in cleanup operations. EPA's research efforts are centered in four National Environmental Research Centers. These centers are located in Cincinnati, Ohio (Municipal-Industrial Technology); Corvallis, Oregon (Ecological Studies); Las Vegas, Nevada (Monitoring); and Research Triangle Park, N.C. (Health Effects). The Edison Laboratory, which reports to the Center in Cincinnati, conducts research in the development of new hardware to contain and recover oil spills, prevention of spills, chemical characterization of spilled oil, and new method development to determine the damages resulting from spills.

The purpose of EPA's participation in this symposium, and of funding efforts such as the one which made this symposium possible, is to develop damage assessment techniques. Our expertise is primarily scientific. We know how to answer questions concerning, for example, oil/water emulsion toxicity. But we realize that we must address ourselves to broader questions, and the economics and social impact of damage assessment pose several pertinent ones for discussion.

The actual financial cost of cleanup operations is readily available to us and fairly constant. Cleanup costs for the Santa Barbara oil spill cost Union Oil $4 million. Cleanup companies estimate costs at from $.50 to $14 a gallon, but we have no accurate way of knowing just what value we are getting for our money. Is the $2 a gallon cleanup any better or worse than the $14 a gallon? Will the long-term results be any different? And we should remember that we are not talking about catastrophic spills as much as the daily incidents, the small spills. Seventy-five per cent of the spills reported to us involve less than 100 barrels of oil each, and the major sources of these spills are shore-side, involving terminals, tank trucks, tank cleaning, and auto crank case spillage.

Once we know that a spill has occurred, we assume responsibility for its cleanup. Our immediate action is to contact the responsible party. If the on-scene coordinator assesses that the responsible party won't undertake the cleanup, or if no responsible party can be determined, we begin our cleanup operations immediately. The costs for cleanup are relatively stable and can be estimated prior to an incident. In fact, the Coast Guard even has standardized rates for equipment use. We consider the variables in expense: the time of year, the extent and location of the spill, and the uses of the land involved (i.e., is the beach recreational?) Our primary concerns at this time are the containment of the oil, its recovery, and land removal or reclamation when necessary.

Of course, our cleanup efforts indirectly protect the environment by removing a pollutant, but our real concern is the restoration of the environment, the mitigation of impacts. The uncertain costs are not those of the cleanup operations, but the costs of restoration. We can replace soil and reseed on land. In water, if mortality hasn't been too high, we can restock the affected species. But we cannot return the entire food-web to its pre-spill condition. We can clean oil-soaked birds, but we cannot go into a store and buy a new supply of plankton.

Just how far mitigative efforts will go in the future, we don't know. In the Long Island spill, restoration consisted of removing the beach. Contamination caused by leaching prompted this decision, and approximately 12 inches of the beach had to be removed. We did not replace the sand and I don't think the beach will restore itself in the near future.

This leads us to ask perhaps a most significant question. Can we, or should we, affix a dollar value to

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the recovery/restoration system? Can we tie a price tag to a mallard duck? Well, a mallard is a game bird, so we probably could, but what about the other elements of a food chain? Can we put a value on phytoplankton and copepods? If we can, how can we incorporate it into a damage recovery system? Who do we charge, if there is a charge?

These are all questions which need to be answered. We know that certain cleanup costs will be recovered either by the federal government or the responsible party. Such considerations as bird cleanup and even aesthetic damage may receive compensation, but the damage assessment picture is incomplete without consideration of the economic and social impact of the spill incident, and we really haven't begun to quantify these. In fact, we don't know if they're quantifiable, and seen in this light, the question of the true dollar value of cleanup, an all-inclusive cost-benefit analysis, may be impossible. Therefore, damage assessment, in its broadest sense, is neither biological nor economic nor social. Its parameters are still to be defined, and, hopefully, this symposium will further EPA's progress toward a definition.

III. THE LEGAL RESPONSE

INTRODUCTION

Having gained an idea of what is done for impacted natural systems, the participants began their investigation of assessment techniques for the impacts on social systems. The third session moved into the social realm by examining the legal response to oil spills, this being the major forum for damaged parties seeking relief for oil pollution damage. Three attorneys discussed ways in which the legal community sees the problem.

Bobby L. Stratton provided an overview of the pollution problem from his experience as an attorney within the Tennessee Fish and Game Commission. Using the principle of common law that the state is the owner of all wildlife, he has been able to convince polluters to compensate for wildlife killed by pollution. Stratton also informed the participants that dollar values for fish have been assigned and that these inventories are available through the Southern Branch, American Fisheries Society.

Thomas R. Post described the current legal status of private citizens seeking compensation for damages resulting from the accidental spillage of oil. He briefly enumerated the relevant legal means for receiving compensation, discussed the failings of these remedies, and cited three existing methods of receiving compensation that have been initiated by state legislatures. Post then presented his suggestion for a means whereby citizens could receive compensation. He stated that a proliferation of various state laws will not insure equal treatment for all citizens and, by placing restrictions on oil transportation, could only increase public inconvenience. He proposed that a federal fund be established to provide adequate compensation for private claims and to minimize certain inadequacies existing under current maritime standards of liability.

Joseph Sweeney described in detail the actual workings of current compensation procedures. He showed the participants how the law would interpret a variety of claims arising from an oil pollution incident.

Sweeney enumerated which parties would be able to receive compensation and which tort principle would be used to successfully prove the claim. Beachfront property owners, shellfish bed owners, states owning public beaches would all have a good chance of receiving compensation for pollution damages. The question of which economic criteria receive judicial consideration was raised during this presentation. It was pointed out that beachfront hotel owners can collect for soiled towels, carpeting, and beach equipment, but the calculation of lost revenues due to adverse publicity is far more difficult. In the ensuing question and answer session, the participants concluded that, although current means for receiving compensation for pollution damages do exist, comprehensive international and national legal frameworks are lacking.

THE ROLE OF THE STATE IN DAMAGE ASSESSMENT – TENNESSEE, A CASE STUDY

BOBBY L. STRATTON
Staff Attorney,
Tennessee Game and Fish Commission

In early 1960, officials of the Tennessee Game and Fish Commission were keenly aware and concerned with the increasing amount of pollution in Tennessee waters. Tennessee, like most of the states at the time, had water quality control agencies. These agencies were controlled by a regulatory board of citizens appointed by the governor. Most of the board members were representatives of either municipalities or industries. For instance, one board member was connected with an industry that was considered one of the major polluters. These people were not intentionally derelict in their duties; however, as human nature would have it, they did tend to protect their own interests.

Some progress was being made, but not nearly as fast as we felt that it should. We began to look at the way to do something about this. Under the Tennessee Game and Fish Code, there is a provision that prohibits the discharge, dumping, or throwing of any deleterious substance or coal tar, saw dust, etc., into the streams in quantities injurious to fish life or in quantities which could be injurious to the propagation of fish. However, such terms as "could be" are extremely broad and confusing.

The maximum fine for such violation is $50. Game and Fish officers issued warrants against those guilty of causing the pollution and had varying degrees of success in the courts. One of our biologists obtained a warrant against a city and was successful in having that city found guilty. We soon realized that a $50 fine was not a very strong penalty or deterrent for the larger industries and cities.

I had just finished law school and could not understand why polluters should be permitted to get away with polluting. In reviewing the laws that we had on the books and trying to determine something to do, the idea struck me that inasmuch as, by law, the state is the owner of all wildlife and title is vested therein, there is no reason — or there should be no reason — why people who destroy this property should not pay for it. This would be no different than destruction of other state property.

I approached the attorney general's office with this idea in 1964, after a fish kill had occurred at a chemical plant. On my first visit with the attorney general's office I did not receive much encouragement. I went back and talked with them several times and finally convinced them that this was a tort act or could be considered a tort act and for that reason we should file suit. The attorney general finally agreed and a suit for $7,500 was filed. To their amazement, within a few months the company made an offer to settle out of court. This claim was settled for about one-third of its actual amount. With this settlement, I felt much encouraged.

One of the problems we had, however, in developing the case was to ascertain the monetary value of fish. In order to come up with values that we felt would be sufficient, Mr. John M. Stubbs, a biologist with the Tennessee Game and Fish Commission, canvassed all of the states in an attempt to determine the cost of the various species of fish. With this information he prepared a book entitled, "Monetary Values of Fish." This book contained the average cost of fish based on size and species.

In 1970, the Southern Division of the American Fisheries Society developed updated values for fish kills. Consideration for these values is both objective and subjective; however, most of the subjective considerations cannot be converted into a monetary value. Some species are valuable in their ability to control undesirable or potentially undesirable plants or animal pests. The rare or endangered species primarily have only aesthetic value; however, species in this category are often vital and nearly lost in their roles as predators, forage, scavengers, and biological control. Another value is the popularity of a particular fish and its value to the fisherman.

After our first success, whenever an incident would occur, I would write a letter to the offender and advise them of the amount of damages and that the letter was serving as a claim for these damages. We received all types of reactions. Usually the first question asked by the attorney for the offenders was,

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"Where is your authority?" I would point out that the title to all wildlife was in the state and that we were bringing a tort action. Apparently, this seemed to have satisfied them. We have not had a challenge on our authority until recently. The challenge now pending is one not for fish but for a herd of deer that was killed by aerial spraying of herbicides. This case is now in the Supreme Court of Tennessee.

The next question the attorneys would usually ask was, "How do you know how many fish are killed?" We would then explain the formula used and the method used. While they were not necessarily satisfied with such a new type of litigation, they were not in a position to challenge it.

This is still an area that, in my opinion, can be improved. On a relatively small fish kill, the biologists are usually able to count all of the fish involved. However, when a larger kill occurs, the fish in given areas must be ascertained and then the total number killed must be projected. Of course this type of system, no matter how accurate, can be attacked in court.

Included in the demand for payment of the fish killed would also be the cost of the investigation. As soon as the attorneys were through asking questions, they would then proceed to attempt to negotiate a settlement. Depending on the circumstances, these matters were settled at varying degrees, including 100 per cent of the demand. Usually the offender would show corrective action being taken in order to insure that such an incident would not occur again. I want to point out that not all pollution cases were deliberate moves on the part of the offender. Some of the incidents were purely industrial or municipal accidents that possibly could have been avoided had the people been on their toes. Others were deliberate discharges, and these were the ones that we did not look too favorably upon in making a settlement.

Our biologists quite often were displeased with the settlement. They felt that any time you compromised on a claim, you were devaluing the fish. I consistently explained to them that this was not necessarily the case, but was merely a legal procedure. This did not change any values that we had established. We were always careful not to eliminate any particular species of fish or to reduce any values on any species of fish, but merely to negotiate the total claim. Sometimes these negotiations would be to recover the expense of investigation. There is still a question as to whether or not such investigative expenses would have stood up in court.

Although there are still problems with the court's acceptance of this type of litigation, we have come a long way in the area of seeking compensation for damages to wildlife. But there is still much ground to be covered in the broadest areas of compensation. The obvious question that could be asked is why do we seek compensation from the wrongdoers in pollution cases? Is it to help our budget, inasmuch as the money collected does go into the operating capital of the game and fish agency, at least in Tennessee? This quite naturally is not the purpose for bringing suits or claims against those guilty. It is my opinion that we do this for a two-fold purpose. The primary purpose is to recognize and pinpoint the violators. The purpose of such recognition is not to condemn them, but to see to it that they do take proper courses of action to prevent such an occurrence. It is also done for the purpose of creating responsibilities — that is, making those responsible for pollution recognize and admit such responsibility. Public opinion goes a long way in this area, also. Industries and municipal officials do not like to be condemned by the public for their actions, especially in industries which want to be considered good neighbors and good citizens; and in most instances they are, in fact, good neighbors and good citizens. Many of these incidents are accidental, not deliberate violations. It appears, however, that industry is not moving quite as rapidly as it could in providing proper treatment facilities of the effluent from its operations. This again is not a condemnation but a recognition that industry does have economic problems and wants to spread such operations over a period of time.

How do we improve the situation as it is today? This is a question with many answers. Probably each person here has a different version as to how we could improve the situation. It may sound strange for me to say this, but I do not feel that the courts would be the proper place to resolve these problems. Again, those who are responsible for discharging into our streams should recognize their responsibility and discharge only acceptable effluent. It is true that they must obtain discharge permits from the Water Quality Control Board. However, the regulations promulgated by such agencies usually are the minimum acceptable to maintain the stream and not the maximum.

There is no overnight solution. I know that in Tennessee existing industries are working harder than ever before to eliminate the problem; however, I still do not believe that they are working at maximum. We must all recognize the fact that it is the responsibility of every citizen in this country to clean up the environment and to maintain cleanliness once we achieve it. This responsibility includes carrying a portion of the cost. Of course, all industries must add to the cost of their product the cost involved in pollution control, and all municipal and private utility districts must pass on their cost to the taxpayers and users. And while we as citizens and consumers must eventually pay the bill, we must at the same time insist that our environment be cleaned, not only for our own personal benefit, but for the generations to follow.

MUST THE PEOPLE SUFFER – SHOULD LEGISLATION BE ENACTED TO PROVIDE A MEANS TO COMPENSATE PERSONS DAMAGED BY THE DISCHARGE OF OIL FROM VESSELS ON THE NAVIGABLE WATERS OF THE UNITED STATES?

THOMAS R. POST

Board of Port Wardens, Private Law Practice,
Miami, Florida

Under current legal standards of liability, great difficulties await private parties seeking to recover damages caused by a vessel's discharge of oil on the navigable waters of the United States. Today, in most states, injured parties must rely primarily on traditional concepts of tort liability intertwined with various aspects of maritime law as a basis for recovery. In this regard, the common law tort concepts of trespass, negligence, and nuisance may be available to an individual initiating an action in either federal or state courts. However, aside from the enormous expenditures of time and money involved in such a lawsuit, the injured party also faces the difficult problem of bearing the burden of proof.

Trespass may be an effective means for recovering compensation for owners of oil-damaged beachfront property, piers, oyster beds, or sea farms. However, the claimant must prove that the discharge of oil which resulted in his damage was intentionally or negligently caused. Moreover, because trespass must involve actual entry or intrusion onto property this would preclude its use by those who can show no actual oil invasion of their property, such as non-beachfront restaurant or gas station owners and the like. Negligence, while one of the principal means for recovering damages for the martime tort of oil pollution, poses a great burden to the claimant in that he must prove the existence of a legal or proximate cause of his damage. This may be particularly onerous for the nonbeachfront owner whose only actual damage may be economic. Nuisance theory may also be a means for compensation recovery if the claimant can prove that his damage is distinct from that of the public at large. Yet, the problems of proving the intentional or negligent cause of the interference with the claimant's use and enjoyment of his land, which gives rise to the theory, and the origin of the oil discharge make this a difficult means of recovery. The martime doctrine of unseaworthiness has also been suggested as a possible means for recovery, but the courts have yet to accept it.[1]

There are several major inadequacies in basing actions on the traditional principles of maritime and common law tort liabilities. Primarily, the shipowner will not be liable to private persons on any basis for damage occurring when a seaworthy vessel encounters an extraordinary peril which results in a non-deliberate and non-negligent oil discharge. Even when this is not the case, the claimant will still have the burden of proving that the spill which caused his injury was either intentionally or negligently caused, or, if the doctrine of unseaworthiness is applicable to such situations, that the discharge was a result of an unseaworthy condition. This burden may be particularly difficult considering the complicated nature of maritime enterprise and activity.

Also, under the federal Limitation of Liability Act,[2] the owner of the vessel may be able to limit his liability for an oil spill to the value of his interest in the vessel causing the spill. Thus, if the aggregate amount of pollution claims that result from a vessel's discharge of oil exceeds the value of the vessel, and limitation of liability is allowed, many claimants may go without full compensation for their damage. Furthermore, if a ship in the process of discharging oil sinks, or is so completely destroyed as to be worthless, or nearly so, and the owner is allowed to limit his liability, pollution claimants may be left without hope of compensation altogether.

On the international level, no convention or treaty presently ratified by the United States provides for private compensation for damages resulting from the discharge of oil from vessels. However, the International Convention on Civil Liability for Oil Pollution Damage of 1969 and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage of 1971 both offer such a possibility.[3] The Liability Convention deals with the liability of the owners of vessels carrying oil in bulk, as cargo to both governments and private persons, for damages caused in the territory of Contracting States by such ship's discharge of any persistent oil. It does not, however, apply to passenger ships or non-tanker cargo ships which are also quite capable of causing an oil spill. Moreover, the liability of a shipowner is limited, in general, under the Liability Convention to approximately $170 per gross ton of the vessel or a total of approximately $17 million, whichever is less, for a single incident. Additionally, such defenses as an act of God, war, negligence or wrongful act of government, or intentional action of a third party can provide the shipowner with a complete shield to liability. The Fund Convention, while not covering the discharge of animal or vegetable oils, otherwise supplements the Liability Convention by increasing the amount of money available to claimants for damage created by a discharge and provides for compensation in general, except where the discharge occurs as a result of war. However, the Fund Convention is also limited in application to discharges from ships carrying oil in bulk as cargo. Thus, even if these two Conventions become ratified by the United States, they will not provide blanket protection in the area of private compensation.

The federal government's response to oil spills can be seen in the provisions of the Federal Water Pollution Control Act.[4] This Act, which incorporates much of the Federal Water Quality Improvement Act of 1970,[5] provides a method for the federal government to recover the costs for the cleanup operations it performs after an oil spill occurs. With respect to private rights to compensation, the Act states that it will have *no effect* whatsoever on the liability of shipowners to any person or agency for damages to any publicly or privately owned property that occur as a result of a spill. The Act merely sets forth deterrent and abatement measures. It provides no benefit to private parties seeking compensation but it does leave an opening for the states to provide such relief when it states:

> Nothing in this section shall affect or modify in any way the obligations of any owner or operator of any vessel, or of any owner or operator of any onshore facility or offshore facility to any person or agency under any provision of law for damages to any publicly owned or privately owned property resulting from a discharge of any oil or hazardous substance or from the removal of any oil or hazardous substance.
>
> Nothing in this section shall be construed as preempting any State or political subdivision thereof from imposing any requirement or liability with respect to the discharge of oil or hazardous substance into any waters within such State.
>
> Nothing in this section shall be construed as affecting or modifying any other existing authority of any Federal department, agency, or instrumentality, relative to onshore or offshore facilities under this chapter or any other provision of law, or to affect any State or local law not in conflict with this section. (Emphasis added.)[6]

In this regard, a number of states have developed anti-pollution legislation which may be helpful to the claimant seeking to recover damages. To date, on the basis of this existing legislation, a claimant may seek compensation, depending on the statute he is attempting to proceed under, in one of three ways:

1) by proceeding according to an administrative or arbitral procedure provided in a given statute;
2) by initiating a civil action on the basis of a private right explicitly provided for in a given statute;
3) by initiating a civil action on the basis of a private right implied in a given statute.

In 1970, Maine enacted a precedential statute[7] dealing with oil pollution and the coastal conveyance of petroleum which established a $4 million, nonlapsing, revolving fund to provide compensation for damages resulting from an oil spill in the waters of the state. Under this statute, a private party may seek compensation by submitting his damage claim to an arbitral proceeding. This approach to the problem is entirely new and, from the claimant's point of view, most adequate. The damages that can be recovered under the new statute are extremely comprehensive and the period of time needed for settling the claim is minimal. Finally, the arbitral proceeding removes the compensation claim from the courts, a forum for substantive maritime law, and thus renders the federal Limitation of Liability Act inapplicable. In fact, the claimant is guaranteed full compensation despite the financial status of the vessel owner or the value of the vessel itself.

The second approach, initiating a private action which has been explicitly provided for by state statute, can be illustrated by recently established legislation in the state of Washington[8] which provides that:

> Any person owning oil or having control over the same which enters the waters of the state in an unexcused manner shall be strictly liable, without regard to fault, for the damages to persons or property, public or private, caused by such an entry. In an action to recover such damages, said person shall be relieved from strict

liability, without regard to fault, if he can prove that oil to which damages relate entered the waters of the state (as a result of

a) an act of war or sabotage, or

b) negligence on the part of the United States Government, or the state of Washington).[9]

This statute explicitly gives a claimant in Washington the right to initiate a private civil suit for the damages he sustains as a result of a spill in the State's waters. Moreover, the strict liability the statute places on persons having control over oil will aid the claimant in recovery by reducing his burden of proof.

Michigan's Water Pollution Control Act of 1970[10] can serve as an illustration of the third method by which a claimant may seek compensation on the basis of state anti-pollution statutes. In one of its provisions, the Michigan statute declares:

> (1) A person owning, operating or otherwise concerned in the operation, navigation or management of a watercraft operating on the waters of this state shall not discharge or permit the discharge of oil or oily wastes from the watercraft into or onto the waters of this state if the oil or oily wastes threaten to pollute or contribute to the pollution of the waters or adjoining shorelines or beaches.
>
> (2) The owner or operator of any watercraft who, whether directly or through any person concerned in the operation, navigation or management of the watercraft, discharges or permits or causes or contributes to the discharge of oil or oily wastes into or onto the waters of this state or adjoining shoreline or beaches shall immediately remove the oil or oily wastes from the waters, shorelines or beaches. If the state removes the oil or oily wastes which were discharged by an owner or operator, the watercraft and the owner or operator are liable to the state for the full amount of the cost reasonably incurred for its removal. The state may bring an action against the owner or operator to recover such costs in any court of competent jurisdiction.[11]

Although this statute does not explicitly provide a private right upon which the claimant may seek recovery, it does not specifically declare that legal rights arising from it rest solely with the state. Thus, under implied cause of action theory, the claimant may be able to utilize the statute in an attempt to obtain private compensation. Basically, implied cause of action theory suggests that the courts can provide the desired relief by creating an entirely new cause of action — not based on traditional common law, but rather on the prohibition that was created by the state statute — or, alternatively, that proof of violation of the statute may be used in a private civil action either as conclusive proof of, or evidence tending to show a violation of, a common law concept.

Unfortunately, however, in a private civil action brought on the basis of either the Washington or Michigan Statutes or like statutes of other states, because the action would be a court proceeding and, as such, subject to overlying principles of federal maritime law, the claimant might be prohibited from a complete recovery or perhaps any recovery at all, due to the federal Limitation of Liability Act.

Along with the development of the various new state oil pollution statutes, a number of questions relating to their constitutionality have evolved. The Florida Oil Spill Prevention and Control Act of 1970[12] can be cited to illustrate some of the difficulties involved in, and constitutional questions relating to, state attempts to provide private relief for oil pollution damage. The Florida Act imposes absolute legal and unlimited financial liability upon oil facility or vessel owners who permit or suffer an oil spill from their facilities or vessels in Florida waters. This liability covers any damages incurred by either the state or private persons. Florida also requires that each owner or operator of a terminal facility or ship subject to liability under the Act must establish evidence of financial responsibility in a manner acceptable to the state.

In *Askew v. American Waterway Operators, Inc.*, a lawsuit which tested the constitutionality of the Florida Act, a three-judge District Court held the Florida Act unconstitutional as an intrusion into the domain of federal maritime law.[13] However, on appeal, the Supreme Court of the United States, in a unanimous nine-judge decision, reversed the lower court's ruling and upheld the Florida act, declaring:

> We find no constitutional or statutory impediment in permitting Florida in the present setting of this case, to establish any 'requirement or liability' concerning the impact of oil spillages on Florida's interests or concerns. To rule as the District Court has done is to allow federal admiralty jurisdiction to swallow most of the police power of the States over oil-spillage — an insidious form of pollution of vast concern to every coastal city or port and to all the estuaries on which the life of the ocean and the lives of the coastal people are greatly dependent.[14]

While the Court made it clear that the states may attempt to develop legislation to provide compensation for themselves and their residents for the damages they suffer from the discharge of oil in state waters, unfortunately it failed to crystalize the liability relationship between such state legislation, the Federal Water Pollution Control Act, and the federal Limitation of Liability Act. Therefore, the question remains as to whether the states may be limited in their ability to provide, through state legislation, adequate private compensation by placing on shipowners a greater degree of liability than the shipowners can presently incur under the federal Limitation of Liability Act.

As the states continue to develop individual approaches to oil pollution legislation, shipping interests become increasingly distressed. They argue that they cannot live with a myriad of state legislation on the subject because it is impossible for them to comply with all the different state requirements relating to insurance, inspections, gear requirements, and state administrative procedures. Thus, the shipping industry claims it will be precluded from carrying out efficient, economical, and logistically feasible operations. This will only prove detrimental to the public which necessarily has to rely on ocean transportation.

Conversely, while there is now no question that the states may enact certain oil pollution legislation, there is no guarantee that they will do so. The disparity between the degree of recovery two claimants with similar damages may receive because they reside in different states may increase as the states continue to develop their own approaches to oil pollution compensation.

What, then, can be done? The establishment of a federal fund to provide compensation for damages suffered by private parties as the result of discharges of oil from vessels might be one solution. A separate fund could be provided for this purpose, or the fund already established under Section 311 (k) of the Federal Water Pollution Control Act as amended in 1972[15] could be expanded to provide all-encompassing compensation for damages directly to real estate, personal property, or income. Recoveries might then be sought arising from one of two concepts:

1) Private parties might be allowed to seek recovery solely from the fund through compensation proceedings which might be either arbitral or judicial, or
2) The fund might be fashioned on the basis of providing compensation for damages sustained by private parties whenever legitimate claims could not be compensated for through existing procedures.

Although this latter method is a somewhat less satisfactory alternative, should it be chosen, the fund could provide compensation to persons suffering damages from oil discharges if any of the following situations should arise:

1) The source of the oil is unknown;
2) The person causing the discharge has successfully raised the defense of either an act of God or an act of war;
3) The person causing the discharge has successfully raised the defense of an act of a third party who is judgment proof, bankrupt, or has satisfied only a portion of the claim, is financially incapable of meeting his obligation in full, or is unknown;
4) The person causing the discharge is judgment proof, bankrupt, has satisfied only a portion of the claim, or is financially incapable of meeting his obligation in full;
5) The claimant has been barred in recovery, either in whole or in part, by the operation of a limitation of liability provision as set forth in a federal statute or an international convention, or:
6) The oil results from a discharge from a public vessel, i.e., a vessel owned or bare-boat chartered and operated by the United States, or by a state or political subdivision thereof, or by a foreign nation, except when such vessel is engaged in commerce.

Should the United States establish a fund of either type, it could be maintained by revenues derived from the importation of oil. If an impost were to be placed on imported oil, the price of that oil could be increased slightly to reflect the additional cost. This would mean that the American public, the beneficiary of oil transportation, would be purchasing oil at a cost reflecting its true price, i.e., a price including the damage costs that others may suffer as a result of its transportation prior to use.

Moreover, whenever the United States could recover money expended from the fund for oil damage from the responsible party, the fund could be reimbursed. This process would be similar to the one the federal government already uses in recovering cleanup costs as covered in Section 311(f) of the Federal Water Pollution Control Act.[16] Therefore, only money expended from the fund for non-recoverable damage would have to be provided for by an impost on oil.

Additionally, such a fund could be established so as to supplement the recently proposed international conventions if they become ratified by the United States, thus helping to eliminate some of their shortcomings.

Finally, the institution of such a fund might make it practical for the federal government to preempt the field of liability for oil pollution. By eliminating the burden to the shipping industry of multiple state legislation, such a fund would provide an adequate means by which all private persons, despite their state of residency, could be compensated for the damages they suffer as a result of the discharge of oil from vessels on the navigable waters of the United States.

FOOTNOTES

[1] T. Post, Private Compensation for Injuries Sustained by the Discharge of Oil from Vessels on the Navigable Waters of the United States: A Survey, 4 Journal of Maritime Law and Commerce 25, 1972.

[2] 46 U.S.C. §§183-189 (1964).

[3] The Conventions are hereinafter referred to, respectively, as the "Liability Convention" and the "Fund Convention." For the text of the Liability Convention, see 9 Int'l Leg. Mat. 45 et seq. (1970). For the text of the Fund Convention, see 11 Int'l Leg. Mat. 284 et seq. (1972).

[4] 33 U.S.C.A. §§1251-1376 (Supp. 1973); Act of Oct. 18, 1972, Public Law No. 92-500, 86 Stat. 816.

[5] 33 U.S.C.A. §1161 (Supp. 1971).

[6] 33 U.S.C.A. §1321(o) (Supp. 1973).

[7] Oil Discharge Prevention and Pollution Control Act of 1970, Me. Rev. Stat. Ann. Tit. 38 §§ 541-57 (Supp. 1973).

[8] Washington Water Pollution Control Act. Rev.. Code Wash. Ann. Tit. 90 §90, 48.315-90. 48.336 (Supp. 1973).

[9] Rev. Code Wash. Ann. Tit. 90 §90.48.336 (Supp. 1973).

[10] Water Pollution Control Act of 1970, Mich. Comp. Laws Ann. §§323.331-323.342 (Supp. 1973).

[11] Mich. Comp. Laws Ann. §323.337 (Supp. 1973).

[12] Florida Statutes §§376.011 – 376.21 (1971).

[13] 335 F. Supp. 1241 (1972).

[14] 411 U.S. 325, at 328,329 (1973).

[15] 33 U.S.C.A. §1321(k) (Supp. 1973).

[16] 33 U.S.C.A. §1321(f) (Supp. 1973).

PRIVATE DAMAGES FROM OIL SPILLS IN A MARINE ENVIRONMENT

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A great scientist 500 years ago foresaw the ecological disasters from water pollution that could be expected in the future. This is what Leonardo da Vinci wrote:

> And the day might come when spendthrift nature will be without water. . .the rivers will be deprived of their waters, the fruitful earth will put forth no more her light verdure; all the animals, finding no fresh grass for pasture, will die, and food will then be lacking to the lions and wolves and other beasts of prey and to men, who after many efforts will be compelled to abandon their life, thus the human race will die out.[1]

Today our scientific community is divided in its predictions. Some say the oceans are not endangered because there is an endless capacity to absorb waste. Others say that we are in an ecological crisis right now, headed for disaster.

In the legislature, where public policy is enacted into law, it is possible to make a choice between conflicting scientific viewpoints based on probabilities. The legislature, in selecting policies, makes a rational choice. The difficulty with the subject matter of our program is that the courtroom is a difficult forum to consider rational choices based on probabilities. One may attempt to enforce a social policy in court; e.g., to make people more careful by the threat of enormous damages, but the tools of private party litigation are not designed to handle all the considerations which physical scientists, economists, and political scientists would raise in a search for the possible costs of a spill. How do we go about making the transition from the types of costs which the legislature might consider in reaching a decision to impose stricter controls to the types of costs which the private litigant might assert against the oil industry defendant?

Let me start off with a couple of basic principles. Losses are not compensable in court without 1) a theory of liability and 2) a theory of damages.

In private law damage theory, there has always been a clear distinction between what the law considers to be physical damages: personal injury or property damage and economic loss (loss of market or loss of opportunity). The law has well handled the problem of physical damages, but not that of economic loss because of bias against permitting recovery for economic loss. The origin of the bias is the belief that the evidence supporting such loss will be either perjured or unreliable.

In the law of contracts liability occurs because of agreement between the parties — a strict kind of liability that admits few defenses. The possibility of recovering for economic loss is not precluded, but the parties must have foreseen the possibility of that type of loss at the time of the contract in order to recover.[2]

On the other side of the law of private obligations is tort law where the liability is created by operation of law rather than by agreement between the parties. Tort law encompasses all types of physical damage, but there is a decided bias against recovery of economic losses.[3] Strangely enough, the one area where one can obtain the recovery of economic losses is from the type of liability created from the medieval writ of Trespass Q.C.F.[4] Under the medieval writ of some 700 years ago, the trespasser is liable for the physical damages which he causes by his intrusion and for all the losses that are the natural and reasonable consequences of it. In negligence law and in strict liability law, in modern tort theory, damages are limited to those which flow from the risk of harm which has been created, and not all the consequential losses of an act. Economic loss is not recoverable in negligence and possibly not in strict liability law either.[5]

Damages cannot be speculative; they must be quantifiable or the judge will refuse to submit the evidence to the jury. The principal means of quantifying damages for the jurors is by the valuation of the market place; the claimant must introduce evidence

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of the market value of the property damaged or destroyed. Only when it can be proven that there is no market, can an alternative such as the replacement cost be used.[6] Another problem is with respect to damages identifiable over a short term as opposed to damages identifiable only over a long period. There is only "one bite at the apple"; that is, only one lawsuit can be brought by a plaintiff as the result of a tortious act.[7] The plaintiff must, in his lawsuit, prove all the damages he then knows. One cannot begin an action for short-term losses, make a recovery for those losses and then later sue for long-term losses. There are also problems with statutes of limitations; in tort law, in this country, the plaintiff's right to sue for a loss due to negligence will expire in three years. This makes it impossible to sue for damages which the scientist would like to examine over a ten year period.

A practical problem in lawsuits is that proof has to be given by the witness's testimonial evidence. Plaintiffs need to have experts willing to testify in order to establish a standard of care in negligence. Witnesses, of course, are subject to cross-examination. Also, the opponents can come up with their own experts. Thus, it cannot be predicted in advance what the result of attempts to prove losses in court will be. Lawyers generally feel that anytime one has to go to court it is a disaster for both sides because the outcome can never be predicted.

At the present time there is a whole range of risks in pollution incidents, but only a few are quantifiable by the courts. Before listing the risks it is necessary to note a couple of platitudes. For the foreseeable future there is no adequate substitute for oil. Our human environment is oriented to the petroleum industry and social policy is now concerned with how to accommodate the human environment to the petroleum industry. Perhaps the question should be the other way around — how to accommodate the petroleum industry to the human environment. Nevertheless, our entire civilization is dependent on this risk-filled industry. A big problem is that oil is not now produced where it is needed. Secondly, it is a hazardous commodity, in layman's language, in all stages of its production, transportation, and consumption. The specific hazards vary, of course. Gasoline is volatile. Gas fumes are explosive. Refineries have a terrible smell. Oil pollution of the ocean can kill all sorts of sea creatures and sea birds, as well as spoil vacations for humans. We must bear in mind that we do have to live with this industry and it must live with us.

What are the risks of oil pollution from vessels? Firstly, there is the destruction of fish, shellfish, and seabirds. Normally, the loss of wildlife is the type of loss for which no private party can bring an action. If anyone could attempt to make such a recovery, it would be the state as *parens patriae.*[8] With respect to damage to fishing gear, small boats, beach installations or to the beach itself, it is usually a private party who is interested in making a recovery and not the state itself, unless state recreational facilities are damaged. The other type of loss is the loss of natural beauty with the consequent loss to tourism. Can anyone recover for that? At the present time the answer to that question is "no" for both individuals and the state. Lastly, there is the expectable risk that public funds must be expended to clean up the spill and attempt to mitigate the losses. Oil pollution is not a danger to human life; rather, it is a danger to the quality of life. This is a situation where private and public interests must be interwoven.

The tort theory that has been most prominent in the past few years is that of channeling all or most liabilities through that party which is best able to insure against them.[9] And, of course, in an oil pollution situation, the most obvious potential defendants are the vessel owner interest or the cargo itself. Another possibility might be to spread the liability throughout the entire community by means of federal responsibility financed from the general budget. However, if the public did assume that burden, it would be in competition with such "amenities" as schools, hospitals, museums, orchestras, and the $80 billion military budget. Thus, from the viewpoint of public policy it seems likely that the channeling of liability will result in greater liabilities for the oil industry or the oil-transport industry with the expectation that the consumer will ultimately pay for the increased costs of insurance.

What are the types of actions that can be brought by the private party? Let me begin with the common law.[10] In the common law (and also in the General Maritime Law) a vessel owner is responsible for a negligent spill. The problem, however, is how is the negligence to be proven? What standard of care should be applied? Should we go beyond the standard of ordinary negligence to make it easier for a private party to prove his losses?

The question of how much is required to be proven has been a difficult one in the past few years. One solution that the oil industry was successfully able to obtain by legislation in 1966[11] was that the party has to prove gross negligence.[12] No one would approve that idea today. But ordinary negligence itself is not so easy to establish. A plaintiff has to be able to show what went wrong on the vessel. A theory that has recently been used to get around that requirement is known by the Latin tag, *res ipsa loquitur* — "the thing speaks for itself."[13] It is a theory in law which may shift the burden of proof from the plaintiff to the defendant. In the *res ipsa loquitur* situation, if the plaintiff establishes the fact that he has been injured, and that it is a *res ipsa loquitur* case, then the burden of evidence to prove non-fault is on the defendant. The traditional negligence requires the plaintiff to prove fault, and this can make a considerable difference when one considers the expense of paying experts to come and testify before the court. A recent case illustrating the use of *res ipsa loquitur* in the oil pollution situation is *California v. SS Bournemouth.*[14]

Strict liability occurs where the plaintiff need prove only injury and the defendant may attempt to prove non-fault by a restricted list of defenses such as Act of God, Act of the Public Enemy or Criminal Intervention of a third party. There is another stricter standard — absolute liability, which admits no defenses whatsoever. We do not yet have absolute liability in the oil pollution situation, and it is likely that we never will.[15]

In addition to negligence liability, the common law provided the remedy of the writ of Trespass Q.C.F. — i.e., *quare clausum fregit.*[16] Trespass permits the plaintiff (landowner) to recover for any intrusion into his close — any intrusion into his space. At the present time there are three theories concerning the use of trespass Q.C.F. In the common law states of the Eastern Seaboard, the law of trespass is essentially the same as it was in England in the fifteenth century. There is a liability for the intrusion alone; nothing else needs to be proven other than the intrusion.[17] New York has a special variation; it requires an affirmative volitional act by proof of the exercise of decision.[18] Most of the country has moved away from the strict common law of intrusion alone. In a majority of the states negligence, deliberation or intent must be proven in order for there to be a trespass action.[19] The trespass action has great possibilities because it has always permitted the recovery of consequential damages, which may include economic loss. Negligence is limited by the risk the defendant created by his conduct — and it certainly does not cover damage in terms of economic loss.

The other possibility for recovery in the common law is the theory of nuisance.[20] There are two types of nuisance. One is private nuisance, which is an action designed to protect a landowner in his enjoyment of his land. Generally, for a landowner to recover, he must show that the damage is permanent,[21] although there has been some case law which has permitted a less-than-permanent damage to be the subject of a nuisance action where the harm done was substantial.[22] One of the great difficulties in recovering damages through a nuisance action is that the court is required to perform a weighing process — to weigh the social interest of the landowner against the social interest of the defendant.[23] The other type of nuisance is called public nuisance. The potential plaintiffs are limited, however. All the states permit public officials such as the attorney general to bring an action for public nuisance. It is not always possible to persuade a public official to bring action. Private citizens have also been permitted to bring action in public nuisance cases where they have been directly injured themselves.[24] Public nuisance is used in a situation where someone has done an act which impares the entire community.

In maritime law, there is also the possibility of a recovery for negligence. It is essentially the same standard of care as for land law. There is, however, an interesting possibility in the remedy which is traditionally available to seamen, which is the remedy of unseaworthiness. This is a type of liability without fault that permits for recovery of damages due to defects.[25] In one case, *State of Maryland v. Amerada Hess,*[26] the court held that there was no recovery for unseaworthiness in an oil pollution case; however, an interesting dictum was added: that after July 1, 1974, there might be such an action by reason of the Rules and Regulations for protection of the marine environment relating to vessel design and construction which the Coast Guard will have enacted pursuant to PL 92-340, the Ports and Waterways Safety Act of 1972.

One of the difficulties with the admiralty remedy is the fact that the defendant, the vessel owner, is permitted to limit his liability to the value of the vessel after a disaster has occurred.[27] When the British Air Force bombed the *Torrey Canyon* to burn the last remaining oil, nothing was left but a lifeboat, and the owner attempted to limit his liability to the value of that lifeboat — about $50.[28] In addition, the shipowner's hull insurance proceeds are not added to the fund for recovery of damages when a shipowner loses his ship completely.[29]

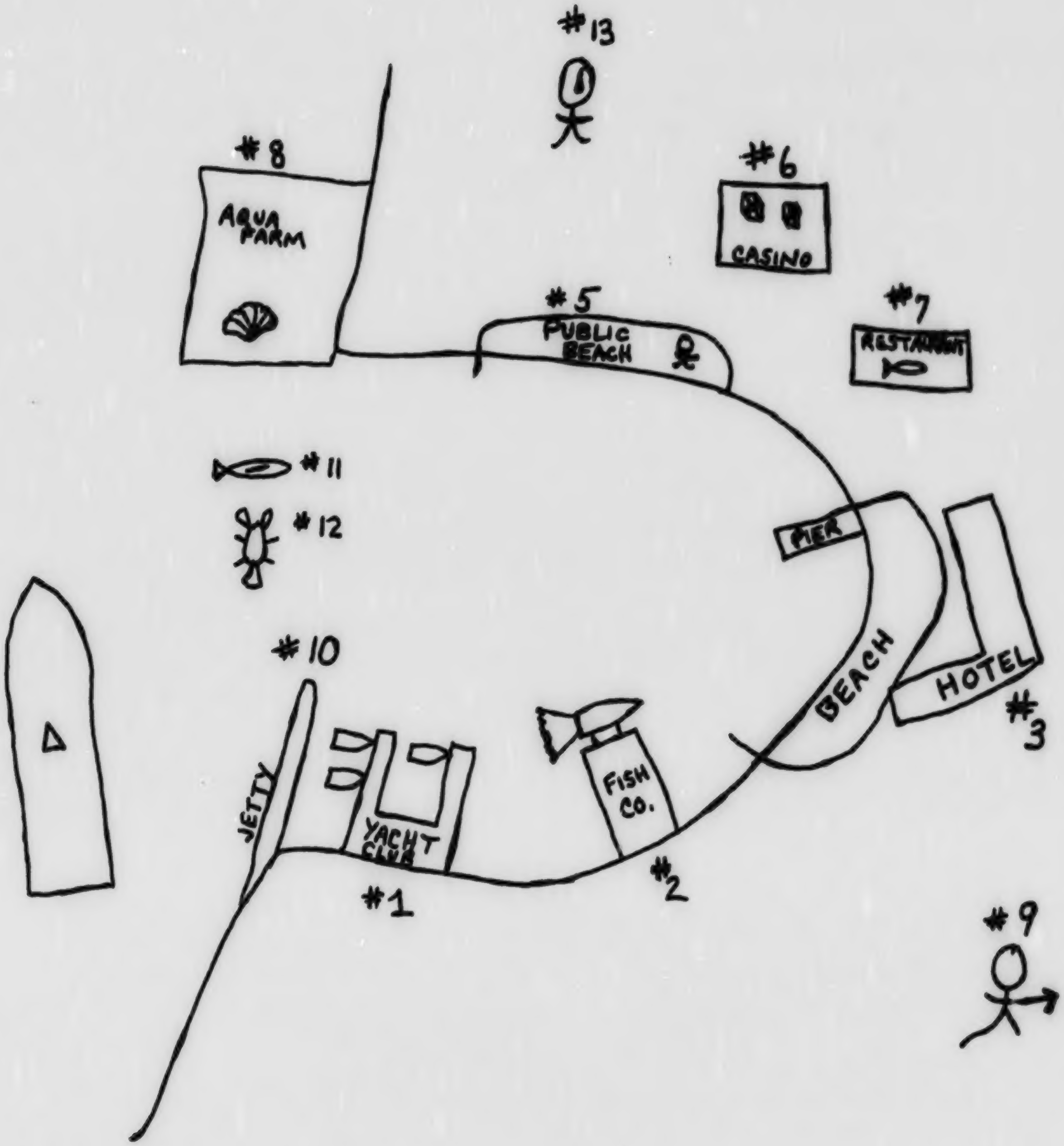
There are a few states where there is what is called direct action recovery in which a plaintiff can bring his case directly against an insurance company, instead of, or in addition to, the insured defendant.[30]

The P & I insurance companies are also not happy with the new developments in federal legislation in which they may be liable to a triple threat arising out of the same facts: a civil action brought by the federal government, a fine by the federal government, and the actions brought by private parties which I have been discussing.

There is support in the case law for recovery of the loss of opportunity of recreation. This was a decision written by a commissioner, that is, a lawyer who was appointed by the judge to hear facts in a case. The decision was in regard to a spill that occurred in New Haven Harbor about 20 years ago.[31] I cannot point to a case which has demonstrated the method of recovery for loss of aesthetic values, but there are some analogies which might be useful. In a recent decision of the District Court of the District of Columbia, the court maintained that an individual claiming injuries resulting from aesthetic and environmental concern has standing to maintain an action to challenge the grant of a refuse act permit.[32] Army Corps of Engineers Regulation — #1165/2/2 of 15 February 1968, *Consideration of Aesthetic Values in Water Resource Development*, states that development plans must now have three components: an engineering study, a cost-benefit analysis and an aesthetic evaluation. The Army Corps of Engineers will recommend development of the water resource only if convinced that the sum of the economic and aesthetic gains will exceed the sum of the cost and aesthetic losses.

Let us give a few examples of potential plaintiffs in an imaginary oil spill case.

First, we have the defendant — the vessel which has run aground and caused the spill. We will assume that it was a negligent spill; the vessel went aground because it did not stay within the correctly charted and marked channel.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#10
JETTY
YACHT CLUB
FISH CO.
#1
#2
#9

Potential plaintiffs in an imaginary oil spill case.

Plaintiff # 1 is the owner of a yacht club. The oil spill has fouled small boats at the club, but the damage has been limited to areas below the low water mark. There has been no damage to the property itself. Since the facilities are on the navigable waterways of the U.S. the club will not be able to bring an action for trespass. It brings an action in negligence for fouling the small boats and the pier. A recovery can be made.[33]

Plaintiff #2 is the commercial fisherman whose boats and nets have been fouled by the spill. The fisherman will be able to recover, under negligence principles, for the fouling of his gear.[34] He will not be able to recover for the loss of his catch, since he has not yet caught the fish. The same might be true if the size of his future catches were to be affected.[35]

Plaintiff #3 is the owner of a beachfront hotel which has swimming and boating. Since the hotel owner is a property owner, he can bring an action for trespass Q.C.F. for intrusion onto his beach.[36] The medieval action is going to permit him to recover for economic loss — loss of the number of reservations in the hotel; he also can recover for damage to his property.

Plaintiff #4 is the non-beachfront hotel owner, who seeks to recover for his economic losses; he probably has no recourse now against the vessel interest.[37]

Plaintiff #5 is the state — as owner of a public beach where people can enjoy the sand and the sun. The state has the right to recover for its losses under trespass and negligence similar to other property owners. The sunbather who cannot get a good tan because the beach is closed probably has no remedy.[38]

Plaintiff #6 is the owner of the gambling casino. He claims economic loss alone because of the spill and also has no recovery.[39]

Plaintiff #7 is the owner of the fish restaurant on the water. The proprietor who serves a piece of inedible fish to a customer who consequently gets sick will be liable to the customer on the basis of breach of warranty in product liability, but this recovery may not extend to the shipowner.[40]

Plaintiff #8 is the operator of an aquatic farm. He has a lease from the state and raises clams, oysters, and scallops. The leaseholder will be able to recover under trespass and negligence.[41]

Plaintiff #9 is the departing tourist, who comes into town, gets a whiff of that oily smell, and leaves. There is presently no way to quantify the economic loss to the community of the lack of patronage of departing tourists.

Plaintiff #10 is the state which has built a jetty. The jetty has been fouled by the oil. The state can sue under trespass and negligence.[42]

Plaintiffs #11 and #12 are the fish and lobsters affected by the spill. The state can sue, as *parens patriae*, i.e., as owner of the wildlife, for recovery of losses.[43] This cannot be done by statistical probabilities. The actual number of dead fish must be counted.

Plaintiff #13 is the ecologist who sheds a tear on the polluted beach. He has no basis for recovery.[44]

If the spiller cannot be identified, the cleanup costs at least can be recovered from the federal government.[45] There is no provision for recovery of any other type of pollution damage in such a case. Perhaps we should handle the problem the same way New York State has handled the problems of the victims of unknown assailants — with a Crime Victims Compensation Board financed from the general revenues.[46]

As a result of the two IMCO conferences held in 1969 and 1971, shipowner and cargo liability are apportioned in an unusual manner.[47] There is a strict liability on shipowners, although limited to $100 per ton to a total of $14 million. The 1971 Fund Convention sets up a fund which will be liable to a total amount of $30 million for expenses not covered by the 1969 Convention. The Foreign Relations Committee of the Senate has this year recommended that the U.S. ratify the 1969 Convention provided that the 1971 Convention is also ratified. I believe Liberia is the only country which has ratified the Conventions so far. From the point of view of the American ecologist or property owner, we can regard the conventions as not completely satisfactory, but on the other hand, we are not likely to get anything better at this time in an international forum. What should the U.S. do? Should we make reservations as to the amount of liability? Our domestic legislation[48] covers only cleanup costs, the liability being limited to $100 per gross ton for a total of $14 million. Private interests are not covered by this statute.

Should we refuse to ratify the international conventions because the $30 million fund might not be large enough to adequately compensate for all the damages incurred from a large spill? I think it would be a mistake not to ratify the Conventions in the interest of international uniformity. Furthermore, our present domestic legislation is concerned solely with the cleanup costs, while the international conventions cover all the possible claims. Thus the area of conflict between domestic and international legislation is not great, and the United States would have the option to reenact the old cleanup law after ratification of the Conventions because the Convention would supersede pre-existing inconsistent legislation.[49] Such reenactment might cause international claims to be brought against the U.S. for violating the treaty. However, we might consider the example of our Canadian brothers who are attempting to force international recognition of a broad coastal-protective principle in oil pollution cases by the Arctic Waters Pollution Act.[50] It is to be hoped that future international conferences, such as the Law of the Sea Conference to be held at Caracas in Spring, 1974, will recognize and enforce the rights of coastal states to protect their environment by the threat of large damage recoveries.[51]

FOOTNOTES

[1] British Museum Ms. 155V.

[2] Hadley v. Baxendale, 9 Ex. 341, 156 Eng. Rep. 145 (1854).

[3] Petition of Kinsman Transit Co., 388 F2d. 821 (2d. Cir, 1968).

[4] Trespass Quare Clausum Fregit, i.e., Writ of Trespass because defendant broke plaintiff's close or intruded on to plaintiff's real property. However, there are limitations here too, see Clark v. Gay, 112 Ga. 177, 38 S.E. 81 (Ga., 1907).

[5] See T.W.A., Inc. v. Curtiss-Wright Corp., 1 Misc. 2d 477, 148 N.Y.S. 2d 284 (1955); Creedon v. Automatic Voting Machine Co., 243 A.D. 339 (1955).

[6] See Standard Oil Co. v. So. Pacific Co., 268 U.S. 146, 155-6 (1925).

[7] The legal doctrines used to protect defendants from paying more than once for the same tortious acts are called "Res Judicata" and "Collateral Estoppel."

[8] State of Maine v. S.S. Tamano, 357 F. Supp. 1097 (D. Me. 1973) 5 E.R.C. 1379.

[9] E.g. Seas Shipping Co. v. Sieracki, 328 U.S. 85 (1946). Mitchell v. Trawler Racer, Inc. 362 U.S. 539 (1960); Gutierrez v. Waterman S.S. Corp., 373 U.S. 206 (1963).

[10] "Common Law" is the non-statutory law developed through the English and American Courts. The term is generally opposed to the "Civil Law" which refers to the system of codified law found in Europe which originated with the Roman Law. This paper will not deal with state or federal statutory remedies.

[11] The Clean Waters Restoration Act of 1966, 33 U.S.C. 3432(3) (Supp. 1967), Pub. L. No. 89-753, tit. II, §211(a), 80 Stat. 1252.

[12] Gross negligence usually imports reckless disregard of consequences, willfulness, wantonness, utter forgetfulness of legal obligations and can approach deliberation.

[13] The formal requirements are that the plaintiff establish injury by an instrumentality in the exclusive control of the defendant, that the injury was of a type that would not occur without negligence on the part of someone in control of the instrumentality, and that the plaintiff was not contributorily negligent.

[14] 318 F. Supp. 839 (N.D. Cal. 1970).

[15] Recent international conventions have applied the standard of strict liability in oil pollution cases. The 1969 Convention on Civil Liability for Oil Pollution Damage gave the vessel owner the following defenses: Act of God, act of war or civil insurrection, intentional acts of third parties, and negligent acts of governmental authorities in maintaining navigational aids. (See Article III) 1 J. of Marit. L. & Comm. 375 (1970). The 1971 Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage gave to the fund (established by contributions from the cargo interest) the following defenses only: act of war or other hostilities and the fact that the polluting vessel was a government-owned, non-commercial vessel.

[16] Kirwin v. Mexican Petroleum Co., 267 F. 460 (D.R.I. 1920).

[17] See Dougherty v. Stepp, 18 N.C. 371 (1835). Cf. Rest. Torts 2d. §§165-166.

[18] Wood v. United Airlines, Inc. 32 Misc. 2d. 955, 223 N.Y.S. 2d 692, aff'd, 16 App. Div. 2d 659, 226 N.Y.S. 2d 1622, appeal dism., 11 N.Y. 2d 1053, 184 N.E. 2d 180, 230 N.Y.S. 2d 207 (1962).

[19] Rose v. Socony — Vacuum Corp. 54 R.I. 411, 173 A. 627 (1934). See also Rest. Torts 2d §166.

[20] Common Law Nuisance, a remedy provided by state law, is a type of liability without fault because of unreasonable activity which interferes with the enjoyment of life or property. A recent Supreme Court case has raised the possibility of a new federal common law of water pollution nuisance. Illinois v. City of Milwaukee, 406 U.S. 91 (1972).

[21] Dixon v. N.Y. Trap Rock Co., 293 N.Y. 509, 58 N.E. 2d 517 (1944).

[22] Patrick v. Smith, 75 Wash. 407, 134 P. 1076 (1913).

[23] See Boomer v. Atlantic Cement Co., 26 N.Y. 2d 219, 309 N.Y.S. 2d 312, 257 N.E. 2d. 870 (1970); Also See Rest. Torts 2d §§852-854.

[24] Hamptom v. North Carolina Pulp Co., 233 N.C. 535, 27 S.E. 2d 538 (1943).

[25] Seas Shipping Co. v. Sieracki, 328 U.S. 85 (1946).

[26] State of Maryland v. Amerada Hess Corp., 350 F. Supp. 1060 (D. Md. 1972) 4. E.R.C. 1625.

[27] 46 U.S.C. §§183-189 (1970) See in re Harbor Towing Corp. 335 F. Sup. 1150. (D. Md. 1971) 3 E.R.C. 1607.

[28] In re Barracuda Tanker Corp., 281 F. Supp. 228 (S.D.N.Y., 1968).

[29] The City of Norwich, 118 U.S. 468 (1886), however, where foreign limitation law is involved, the result may be different, see Petition of Chadade Steamship Co. 266 F. Supp. 517 (S.D. Fla., 1967).

[30] See Olympic Towing Corp. v. Nebel Towing Co., 419 F2d 230 (5th Cir. 1969) cert. den. 397 U.S. 989 (1970).

[31] In re New Jersey Barging Corp., 168 F. Supp. 925 (S.D.N.Y. 1958). In this case 155 beachfront owners sued the owners of a barge which had been discharging heating oil at a pier. The oil spilled into the harbor when the pumpman on the barge fell asleep and there was an overflow. The commissioner rejected the beachfront owners proposal that the damages be computed, on the basis of land values in the going market, at so much per foot of beachfront. The commissioner's finding permitted recovery of out of pocket expenses plus a sum for the inconvenience of the spill as measured by decreased swimming, sunbathing, fishing, boating, picnicking, and aesthetical pleasure.

[32] Kalur v. Resor, (D.D.C. 1971) 3 E.R.C. 1458).

[33] See U.S. v. Ladd, 193 F2d 929, (4th Cir. 1952) A Santa Barbara spill case has held that there is no recovery for loss of recreational boating, Oppen v. Aetna Ins. Co., 42 U.S.L.W. 2205.

[34] See Carson v. Hercules Powder Co., 240 Ark. 887, 402 S.W. 2d 640 (1966).

[35] The Menominee, 125 F. 530 (E.D.N.Y. 1903), but see Carbone v. Ursich, 209 F 2d 178 (9th Cir 1953).

[36] See Small v. U.S., 333 F 2d 702 (3rd Cir 1964).

[37] See Sinram v. Pennsylvania R.R., 61 F 2d 767 (2nd Cir 1932). See also Robins Dry Dock & Repair Co. v. Flint, 275 U.S. 303 (1927).

[38] See generally H.R. Moch Co. v. Rensselaer Water Co. 247 N.Y. 160, 159 N.E. 896 (1928); Motyka v. City of Amsterdam, 15 N.Y. 2d 134, 204 N.E. 2d 635, 256 N.Y.S. 2d. (1965); Shubitz v. Consolidated Edison Co., 59 Misc. 2d 732 301 N.Y.S. 2d 926 (1969).

[39] See Stevenson v. East Ohio Gas Co., 73 N.E. 2d 200 (1946); Petition of Kinsman Transit Co., 388 F2d 821 (2d Cir 1968).

[40] E.g. Greenberg v. Lorenz, 9 N.Y. 2d 195, 173 N.E. 2d 773, 213 N.Y.S. 2d 39 (1962) See also Webster v. Blue Ship Tea Room, 196 N.E. 2d 309 (1964) product liability actions based on breach of warranty against the sellers. The action by either the buyer or seller against the shipowner would be based on tort principles.

[41] Carr v. U.S., 136 F. Supp. 527 (E.D. Va. 1955).

[42] Portland Tug & Barge Co. v. U.S., 90 F. Supp. 593 (D. Ore. 1949).

[43] See fn. 8, supra.

[44] See Tobin v. Grossman, 24 N.Y. 2d 609, 249 N.E. 2d 419, 301 N.Y.S. 2d 554 (1969); Cf. Archibald v. Braverman, 275 Cal. App 2d 290, 79 Cal. Rptr. 723 (1969).

[45] 33 U.S.C. §1321 (f) (1972) See especially U.S. v. S.S. Monsoon 443 F2d 95 (1st Cir 1971).

[46] E.g. N.Y. Crime Victims Compensation Board Act, Executive Law §§620-635.

[47] See fn. 15, supra.

[48] See fn. 45, supra.

[49] See Rest. For. Rel. L. of U.S. 2d §141 for self-executing treaties. For legislation subsequent to treaty see Edye v. Robertson, 112 U.S. 580 (1884).

[50] Arctic Waters Pollution Prevention Act, Bill C-202, 2d Sess. 28th Parliament, 18-19 Eliz. II (1970).

[51] On November 2, 1973, 71 nations present at the IMCO Conference on the Prevention of Pollution from Ships approved the segregated ballast system to eliminate deliberate spills, forbade discharge within 50 miles of land and required that oil discharges be monitored.

TASK TEAM SESSION #1

Following the discussion of a legal approach to damage assessment, the participants were reminded of their initial assignment: to consider development of a viable assessment program. At the opening session Tuesday evening, each participant had received a copy of the first task and had been assigned to a small discussion group. These groups had met informally after the opening session and formally before Wednesday morning's discussion of biological assessment procedures. By late Wednesday afternoon, the seven task teams were ready to present their preliminary responses to the first assignment.

It was hoped that the first two questions of TASK I would establish whether there was a common interest in assessing oil spills at the federal level. If there was initial agreement on the need for a national assessment program, the third question would then provoke discussion among the participants on specific program goals. A copy of TASK I and the edited responses of team representatives follow.

TASK I

The Issue

Task I asks us to address the following set of questions on two levels, first as an individual, second as a task team.

1) Should the government undertake a program to research the assessment of *ecological impacts* (natural community) from oil spills, which could then be used in the development of regulations and enforcement practices?

2) Should the government undertake a program to research the assessment of *social impacts* (human community) from oil spills, which could then be used in the development of regulations and enforcement practices?

If the answer to 1) and/or 2) is yes:

3) What goals should be established for a program designed to assess impacts?

The Approach

Prior to the task team meeting, each participant should develop individual responses to the above questions. The task team will then meet to develop a team response. The team response to each question should be written on a sheet of newsprint, and one team member should be selected to make a five minute presentation to the plenary session.

TASK TEAM I

William Drury, Director, Scientific Staff, Massachusetts Audubon Society

Since we have agreed that some governmental program of research into the ecological and social impacts of oil spills should be undertaken, rather than spelling out specific research goals, we would like to point out some of the concerns that should motivate the direction of such a program. *First, there is an aesthetic concern.* Our research should be underscored by a primary awareness of the effects of oil pollution on our environment. *Second, there is a moral concern* for the natural community. This concern manifests itself most clearly when endangered species are involved, but we must recognize our role as general protectors of other biological forms of life. *Third, we must see the socio-economic importance of our work.* One good example would be the maintenance of the food chain. Certainly one of our goals ought to be to see that the food chain's integrity is maintained, that it continues to function effectively.

Although these are very general recommendations, parallel and included in these overall considerations is the question, "Why should government be involved?" First of all, *the question of the impacts of oil spills involves all levels of society.* Therefore, a third party, one that could deal with the effects on common property, would be a desirable investigator. We can all agree that, at present, private incentives to undertake such a massive research program are inadequate. And, more important, any private initiative would come with strings attached. Could all groups in our society really believe the findings of, for example, an oil-industry-sponsored research program? Along with the question of the bias of private investigations, there is the problem of the random direction such research activities would invariably take.

We would find not only a variety of perspectives, but also a variety of uncoordinated data if such a program had no single, directive authority.

What we desperately need is data relevant to a specified objective, and a coordinated governmental effort seems the best way of getting it. This data could then be used to assess the effectiveness of current regulatory programs and to set up new regulatory or incentive programs with the ultimate goal of de-emphasizing an objectionable activity, oil pollution. Such a system of data analysis and program modification would provide the feedback loop so desperately needed if we are to minimize the impacts of oil pollution. To conclude, *we advocate a research program which would be designed to justify and supervise a mechanism by which undesirable public and private activities could be led to their own demise.*

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TASK TEAM 2

Thomas Cook, Department of Political Science, University of Illinois

Our task team would like to give three general research directives that should be considered. *We must look to present legislative efforts directed at controlling the impacts of oil spills.* Are these programs effective in producing the desired results? If they are, how can we strengthen them? If they aren't, what can we do that would be more effective? After looking at the efficiency of what we currently have, *we should look to ways of developing a research methodology for the systematic assessment of the social and ecological impacts of oil spills.* It is essential that we get reliable data, and the way to go about it would be to develop a framework for management and funding that would be independent of any outside pressures.

The question of who should run this team — oil companies, government, multidisciplinary — was the subject of much debate within our group, as evidenced by our two qualified negative votes, and it will probably continue to be discussed as the week progresses. We did agree, however, *that the research must be directed to the future, toward resource management.* We must try to answer the questions of what our priorities are and what our alternatives are to the present consumption of fuel.

Girard Krebs, Assistant Professor of Sociology, Ohio University

Our team also raised questions on the definition of the first two questions posed to us. Although I'm not here to explain our two qualified "no's" to the first two questions, I do think that we should discuss some of the questions these questions produced in our group. First, when the word "government" is used, what do we mean by it? Different localities have different problems relating to oil spills and different areas of government — state, county, local, metropolitan — have different capacities of response in terms of commitments and resources. We need to consider the uniqueness of the areas we would be studying and a federal approach to this would not necessarily augment the effectiveness of local responses. Another qualification for the term "government" would be that any federal approach would invariably involve jurisdictional disputes among agencies. Who would conduct the study — the Department of the Interior, the EPA, the National Institute of Mental Health? The opinion expressed in our team was that the necessary coordination does not exist on the federal level to handle such an effort.

We must consider the problems of focal point, level of funding, local funding resources, level of local resources, and the applicability of an assessment program to the development of regulations. Specifically, could a research program have concrete applications? Are we capable of conducting a meaningful benefit-cost ratio when there are so many unquantifiables to consider? Governmental agencies respond to choices placed in economic terms, and as yet we have no way of placing a dollar sign on the sight of a man crying over an oil-polluted beach he had once loved to walk upon. How do we measure the psychological costs and then quantify them?

TASK TEAM 3

J. Wardley Smith, Technical Manager, International Tanker Owners Pollution Federation, Ltd.

Team 3 did not face quite as many problems as Team 2 apparently did. We agreed to agree on questions (1) and (2), but rather than delineate any specific research goals, we chose to make some general recommendations. We all acknowledge that there is a great need for further research in the collection and analysis of data. There are areas, such as oil pollution in sweet waters and in mid-ocean, in which research is practically non-existent. We desperately need base line data on pre-spill conditions, but, since it would be impossible to do this for every spot on earth where an oil spill could possibly occur, we suggest determining areas which have a high probability of oil spill occurrence and doing base line studies there. We also need further research on quantifying the unquantifiables. We already know much about the impact of oil spills in terms of damage and replacement costs, but we could make a better effort at understanding those costs to which we cannot assign a dollar value.

Our team found that specific goals were not easy to identify, but we could offer some guidelines for study. Two things need to be examined in order to make the study viable. First, we need to know the public concern for the problem: research must determine what the social indicators are. Second, we must strive for a better quantification of resources so that we can make meaningful decisions on our priorities.

TASK TEAM 4

Norman Sanders, Assistant Professor, Dept. of Geography, University of California at Santa Barbara

Our goals for a research program can be stated very clearly and quickly. We assume that this research would be conducted before a spill, but we advocate that the same procedure be followed after one has occurred. *Our primary goal is the acquisition of information for long and short term decision making which would be of direct benefit to the citizen.* We can accomplish this by gathering accurate, reliable base line data to create a regional overview of sensitive areas. The data priorities aren't listed in order, but they include economics, health hazards (physical and mental), aesthetics, ecological (and biological), political structure (who responds to whom) and electoral politics (who will be influenced by whom). Obviously, this is a very broad task and if one agency, say EPA, tried to do it alone, it would have difficulties. Fortunately, there is a movement going on throughout this country for localities to adopt meaningful land use policies, and this new awareness of the problem, including the psychological and ecological aspects, should make it easy for a coordinating agency to work with local interest groups to generate the necessary base line data.

TASK TEAM 5

Barbara Welsh, Assistant Professor, Marine Ecology, University of Conn.

Our team realized at the onset that we were dealing with a problem both emotional and technological in nature. We all answered "yes" to the first two questions, but did delineate three needs. First, we have no criteria for assessment, and this is crucial to our ability to predict the impacts before a spill occurs. Second, even if we did have a set of criteria, we need some continuing effort at assessment. A governmental agency, using a multidisciplinary staff, would need to continually monitor the changes in the criteria since we assume that variations will occur as we gain more knowledge and develop more refined systems of measurement.

In general, our team was able to raise more questions than we answered. In addition to seeing the need for a set of criteria and for a continuing assessment process, we also saw a third need which is to more clearly define the term "government." Certainly, some consideration must be given to the fact that the problem is international in scope. Also, we must remember that the primary benefit of any such organized endeavor would be that experts, government, and citizens could work together at reaching a common understanding. Our implicit goal would be that the research would have applied benefits and the group effort would be one such benefit.

William Zwerman, Associate Professor of Sociology, University of Calgary

Another benefit, obvious but worth stating, is that the acquisition of knowledge is always helpful. We do a better job with it than without it! I'd like to mention that our team did recognize some difficulties in this acquisition of knowledge. When we talk about ecological research, we can easily talk about its application — gathering benefits, minimizing costs. But when we talk about social impacts, we are talking about both controllable and uncontrollable forces and there is no way of determining what a uniform response would be. Obviously, we cannot do base line studies for the social responses. Instead, we need a continual monitoring process. This process must be integrated with decision making in the political process. Bad political decisions result from inadequate information bases. Such a continuing monitoring process of social response to oil spills would help us to define our alternatives and thus strengthen the process of political decision making.

TASK TEAM 6

Dennis Wenger, Assistant Professor of Sociology, University of Delaware

Although our team answered "yes" to both questions, we found ourselves waylaid, at first, by semantics. "Just what does 'social' mean?" we asked. After some debate, we decided that "social" means anything not biological. Therefore, we suggest that if we're going to study the "social" impact of oil spills, we study the legal and economic systems, the systems of social power rather than local governments, and the group behavior of affected citizens, not just their personal attitudes. In short, we should do a benefit-cost analysis of the broadest scope. But we run into the problem of measurement, and perhaps the way to approach the problem is to begin by assessing the current state of the art. After much debate, we found ourselves agreeing that the only approach to use is the one found in any sixth grade science text, the scientific method. First, we need to know what we already know about assessing the impacts of oil spills. One thing we do know is that we really cannot separate questions (1) and (2). The ecological impacts of an oil spill are the social impacts and vice versa.

We can continue our investigation by defining the goal asked for in the third part of our assignment in a most specific way: how can we arrive at conclusions which can be brought into the decision-making process to aid in the prevention of oil spills? *To meet this goal, we need an analysis of the state of the art and the development of methodological tools such as base line studies and social indicators.*

TASK TEAM 7

Thomas Roush, U.S. Environmental Protection Agency, Edison Lab.

Essentially, our team was in agreement on the answers to questions (1) and (2). For question (1), we all agreed that base line studies on ecological effects are needed, but expensive. For question (2), we came to a conclusion of "yes, more or less." We saw some need for social impact research but raised the question of just what we could examine. We know that dollar value is our current means of quantification for aesthetic damage. What kind of retribution do we make for a lost day of swimming at a polluted beach? And who should make it? In short, we agreed that we need to do research on what kind of research we can do.

SUMMARY

The task team discussions concluded with comments by Charles Bates, of the U.S. Coast Guard, concerning the willingness of the federal government to undertake assessment programs. Bates pointed out that under the National Contingency Plan a thorough assessment of damages is mandatory. This assessment could employ emergency response teams to investigate both the social and ecological impacts. He also stressed that legislation such as the Federal Water Pollution Control Act enumerates such topics for study and encourages federal agencies to undertake assessment programs. An environmental response team, he concluded, would be in keeping with national objectives as contained in existing legislation. Bates also reminded the audience that there are current methods of assessment provided by the federal government, such as floating aides to measure levels of marine life and oil pollution, which are available for general research use, and he suggested that base line studies could be undertaken immediately with minimal expense.

Charles Bates' call for immediate action emphasized a significant aspect of the task team process. When Harold Snyder had asked the participants to answer questions on the public response to oil spill impact assessment, he had stated that the audience, as concerned individuals, should not view these questions as rhetorical. The immediate result of the first task team discussion was an answer to Snyder's first question, "Who really cares about oil spill impact assessment?" The answer was positive and pointed — the participants cared. The response to the first task team assignment showed that the group viewed a coordinated government effort at damage assessment as the most appropriate solution to the problem. Despite some qualifications, there was initial agreement on the first two parts of Task I. In this response, it had also answered Snyder's second question, "Who would you want to hear from?" Despite some concern that local assessment efforts should not be impeded by federal actions, the thrust of group comments was that the federal government, using a variety of outside assistance, was the proper vehicle for future research efforts.

In answering the third part of the assignment, the delineation of goals, the participants showed an understandable conservatism in adopting specific research measures. There was universal agreement on immediately initiating research activities to yield the much-needed base line data in both the natural and social sciences. There was also universal agreement that the ultimate goal of any research effort should be the use of its findings to improve the public decision-making process. Caution was expressed, however, on the group's ability to describe specific research activities since a complete overview of the problem had not yet been presented.

IV. THE CORPORATE RESPONSE

INTRODUCTION

The fourth program session continued the process of informing the participants of current assessment measures. They had learned of EPA's response to a spill incident and had heard the legal views on the problem of adequate compensation for damages. It was now appropriate to consider the private sector's response to the problem of oil spills. The companies most involved in the problem of damage assessment are the major oil companies and their insurance carriers. L.P. Haxby of Shell Oil Company and Ron DeNoville of the Crawford Insurance Company explained the problem from the point of view of those companies faced with the operational realities of cleanup, prevention, and compensation.

L.P. Haxby stated that his company works not only to settle claims brought against it, but also to find ways of minimizing the impacts and occurrences of spills. He discussed industry-sponsored training programs and suggested that all accidental spills can be traced to some instance of poor planning. The oil industry, he stated, looks to its management practices for ways of improving its efficiency in the transportation and handling of oil. He also pointed out that the participants and the general public do not benefit from regarding the oil industry as the villain. Current and future needs and sources of petroleum were discussed and the audience was advised that tanker transportation and the probability of spill occurrences is a problem that will continue to exist.

Ron DeNoville described the problem from an insurance company's viewpoint. He agreed with Haxby's conclusion that the problem of oil transportation and spillage is here to stay and described how an insurance company goes about handling the myriad of damage claims that arise after a spill. DeNoville mentioned that there are many spills which the insurance companies do not handle since the spiller is self-insured. The audience was told that when insurance companies do become involved in the aftermath of a spill, they act rapidly and equitably to settle all just claims. Ways in which insurance companies classify claims and, once again, the question of compensation for nebulous damages such as property values was discussed. DeNoville pointed out that while beachfront property may be damaged as the result of a spill, it has been shown that property values will not necessarily be affected. Therefore, he concluded, the problem of formulating an accurate cost-benefit analysis that will affix economic values to a broad range of damages is a difficult one.

THE OIL COMPANY'S POSITION IN AN OIL SPILL

L.P. HAXBY
Manager, Environmental Affairs,
Shell Oil Company

Before addressing myself to the question of what I believe to be the corporate response to an oil spill, let me first clarify that I am only a representative of one oil company and that, in terms of industry representation at this symposium, I am practically a lone voice. Only four industry representatives are present, two from two companies, and although I have been assured that many other oil companies were invited to send representatives, it should be clear to you that I can hardly claim to present an industry response. I *can* claim, however, that the opinions I will share with you I regularly express within my own job and my views do become input into my company, Shell Oil. I am here to interface with the experts of various disciplines on the question of response to an oil spill, but I am also here to give you some information on what the oil industry is, on why we need oil, on how oil spills relate to oil movement and on how an oil company's response to a spill relates to its conception of corporate responsibility.

First, let me give you some facts and figures on the nature and scope, the significance, of the oil industry today. In 1972, the United States produced 3.3 billion barrels of crude oil or 9 million barrels per day. This can be compared to the total 1972 Free World production of 18 billion barrels, or 49.7 million barrels per day. Thirty-two states produce oil, natural gas or both, and approximately 7,000 firms are currently involved in the search for and production of natural gas and oil. However, the largest producer accounts for only about nine per cent of the total production, and of every 100 exploratory wells drilled in the search for new fields, less than two find enough petroleum to be commercially successful. The drilling of a deep well, which may take six months or more, costs over $1 million.

To give you a further idea of current oil operations, there are approximately 250 oil refineries operating in 39 states and they handle from 1,000 to over 400,000 barrels daily, but the largest single refining company has less than nine per cent of the total capacity. We refine about 25 per cent of the Free World capacity, 13.4 million barrels of crude oil a day. U.S. refineries represent a gross investment of almost $18 billion, and a 140,000 barrel per day capacity refinery may cost as much as $200 million. In 1962-1971 decade, oil company earnings averaged 11.8 per cent on net worth, compared with 12.2 per cent for all manufacturing companies. For the years 1967-69, the U.S. oil industry paid taxes on 5.9 per cent of gross revenue, exclusive of motor fuel and other excise tax, but during this same period the average for all business was only 4.7 per cent. We are primarily a service industry. Our business is to provide oil to meet consumer needs. We are capital intensive rather than labor intensive, and we do have a problem in generating capital flow.

But our main problem at the moment is trying to meet your oil needs. Shell Oil's forecasting group has projected energy needs for the future based on certain premises such as population growth, anticipated environmental and federal regulations, and plant siting. Our figures generally correspond to those established by other oil companies and by the Department of the Interior. These figures, presented in the Shell publication "The National Energy Outlook," show certain problems we will be facing by 1990. Although the immediate demand for oil is increasing, U.S. production is about at its peak. We believe that the production of natural gas has already peaked. Coal will not meet energy demands unless the technology for its liquification and gasification expands its useability. Nuclear power will grow in importance and should make up a major share of our future energy supply. But the bulk of our supply by 1990, 60 per cent is the estimate, will come from the importation of oil, and this greater need for imported oil should affect us in several areas. It will have an effect on the balance of payments, on political and economic policies. It will create a need for new facilities — tankers, super-ports, refineries and pipelines — and it will increase the importance of conservation measures.

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The future of U.S. petroleum supplies is not good. We hope to receive some benefit from the North Slope supply and we have, until 1990, a fair hope of meeting our petroleum needs through overseas and Canadian crude imports. There is no doubt, however, that product imports will increasingly be used to fill our energy needs. We must accept the fact that crude reserves in the Western Hemisphere are minute compared to those in the Middle East. Oil movement will not only continue but radically increase by 1980. While we can hope that between now and 1990 we will improve our efforts at energy conservation, that alone will not provide sufficient quantity to meet our projected deficit. Energy needs and crude oil reserves provide the probability of oil spill occurrences.

Oil spills primarily relate to oil movement. It is a materials handling problem analogous even to the simple materials handling problem of washing dishes. Just as we know that given the time an individual would normally spend washing dishes, there will be an excellent probability of at least a few broken dishes, it is unrealistic to believe that oil can be transported without a single drop being spilled somewhere. Ways of reducing that risk are continually under investigation. The potential sources of spills are identified as marine, pipeline, vehicular transportation, fixed facility, and natural seepage. I believe that the cause of spills is always related to human failure in some way. If the prevention practices are good, the failure is a failure in human judgment. If the practices are poor, the failure then is attributable to improper planning, and if the error is mechanical, we can attribute it to inadequate knowledge and/or poor planning.

Since the cause of oil spills relates to human failure, our task in damage assessment should relate more to prevention than to cleanup. The oil industry has been prevention-conscious for a long time. Our efforts have perhaps not been good enough, but we are dedicated to keep trying to improve them. We know that we hear only of the catastrophic spills and not of the routine, preventive practices such as scheduled replacement of a packing valve and other routine practices within our industry which help us prevent oil spillage. I maintain that the oil company's awareness of its responsibilities for prevention is above and beyond the letter of the law and regulation. It should be clear to you that the public must live with the oil company and the oil company must live with the public. We are obliged to know the law and to comply with it. *There is absolutely no doubt that cleanup is, under law, the spiller's responsibility.* Not only do we comply with the law in terms of monetary penalties, rules and regulations, but in the area of prevention, oil companies often go far beyond legal requirements for various reasons. For example, a 20-well platform may maintain 500 safety and prevention devices where the law requires only 300, or a company practice may require testing its hoses for ship-to-shore oil transfer twice as often as Coast Guard regulations.

Obviously, when we talk about how a corporation views the law, we are talking about the level of corporate awareness to its public responsibility. Certain questions can immediately be raised when we view a corporate response to a spill:

1) Is this company as a whole interested in the problem?
2) Does this interest stem solely from the economics involved?
3) Does this interest stem solely from a social responsibility role?
4) Can it be a combination of both?

It *must* be a combination of both. How strong a company's response to prevention and cleanup is can be judged by looking at the *time, money, and manpower* it devotes to these problems. It can be seen in its research efforts, its operational capability, and its training facilities. We can measure the response by comparing one company's efforts to another's and also by measuring the overall effectiveness of a company's efforts.

My personal view of our present corporate response is that, as an industry, our capabilities are good. In prevention, we have good design, as evidenced in the selection of materials and standards, and we have good operating procedures. In training, we have formal training schools, some provided within individual companies, others sponsored by the industry, through universities, and through private, third-party contractors. Our overall cleanup capabilities in my opinion are good. Operationally, the industry makes extensive use of co-ops to aid this effort. The American Petroleum Institute has an agressive research program with a $1 million per year budget. We attempt to minimize both ecological and amenity damage and recognize compensation through normal legal channels. We understand that some spillage is bound to occur and that prevention planning and cleanup techniques are ongoing activities that must continue to be improved.

But we must all finally ask ourselves this question. When is enough, enough? The law now clearly fixes responsibility on the spiller. I agree that one federal law rather than a proliferation of state laws affixing liability for private compensation would be helpful, but the responsible segment of the oil industry does not need further punitive or regulatory legislation. And it does not generally need help in its cleanup responsibilities. What it needs, in my opinion, is some recognition from the public that societal risks are associated with societal needs and that we must be willing to accept some risks if we expect to meet our society's needs. The oil industry willingly bears the costs incurred. All that it asks for is a realistic appraisal of its role in the complex problem of assessing the costs and benefits of energy consumption.

ROLE OF THE OIL SPILL CLAIMS ADJUSTER – THE MIDDLEMAN

RON DENOVILLE

General Manager, Oil Claims And Oil Services,
Crawford And Company

After handling 11 separate oil spills involving more than 10,000 claims over the past five years as an oil spill claims adjuster, it is very evident that no one wants an oil spill. This particularly holds true for the oil company or their insurance carrier. These parties probably want to avoid an oil spill more than anyone else because they have everything to lose and nothing to gain from it.

There are several major areas relating to oil spills that are of vital interest. We consider them to be prevention, containment or cleanup, and the adjustment or handling of the resultant claims. I will discuss here only the last area, the adjustment of claims. In order to have a better understanding of the adjusting/handling of oil-spill-related claims and the damage assessment of same, we must first discuss and consider the following: basic considerations, types of spills, liability, types of damages, timing, general principles, the concept of the coordinator and, finally, personnel.

BASIC CONSIDERATIONS:

It should be remembered that insurance companies do not become involved in every oil spill. Frequently, self-insurance is involved. In larger spills there can be a combination of insurance and self-insurance depending on the type and extent of coverage purchased prior to the spill. Further, the involved insurance can be either foreign or domestic, and this largely is determined by the type of coverage desired. Different coverages are available regarding refineries, platforms, oil tankers, pipelines, etc. The coverage or underwriting of the spiller can be quite complex.

TYPES OF SPILLS:

There appear to be two distinct types of losses to consider which require separate and distinctive handling.

1. **Small or moderate spills** — which involve individual claims. These claims are generally handled in the same way that normal "non-oil-spill-related" claims are handled.

2. **Larger or major spills** — which may result in multitudes of individual claims and can, in fact, result in class actions. These class actions, if they materialize, greatly complicate the situation in terms of increasing legal involvement and extending the time element involved in resolving these matters. In the Santa Barbara and the San Francisco spills, billions of dollars in class actions were filed.

LIABILITY:

Liability must be determined at an early date. There are many courses which the spiller may take depending on the liability situation. We find that the following degrees of liabilities have a direct effect on if and how soon resolution of the claim problems occurs:

1. **No liability to the spiller** — this may result in the spiller denying all claims and taking no action.

2. **Questionable liability to spiller** — this may result in the delayed resolution of claims while the spiller is determining his liability status. In some cases, the spiller may elect to resolve all claims but will protect his interests by gaining the assignment of each individual claim as the claim is resolved. In this manner, the spiller can then seek indemnity through the courts if such is justifiable.

3. **Clear liability to spiller** — normally this situation will result in a prompt resolution of all proper claims.

TYPES OF DAMAGES:

Damages vary greatly from simple claims such as those on clothing to the more complicated and complex claims of the state or of municipalities. One can expect a variety of claims which may include vessels, fishermen, beachfront owners, business claims, hotels and motels, volunteer laborers, municipalities, states and many others. Proper handling of these claims is essential when dealing with the public in general in order to get the results which are beneficial to both industry and the public.

TIMING:

Immediate action as the oil spill is occurring is necessary. Until the oil spill is cleaned up, literally around-the-clock, seven-day-per-week type action is necessary. Once control results, then the initial surge of effort can be lessened. At all times thereafter, full effort should be maintained toward a fair and prompt resolution of these claims. The best time in an oil spill is when the last claim is resolved.

GENERAL PRINCIPLES:

Handling large spills creates many different problems above and beyond those normally found in regular claims adjusting. There is a long list of principles which are carried out after a major spill and many of these principles may vary greatly from the normal established claims principles which are used in handling other than oil-type claims. Some of these include:

1. Solicit all legitimate claims. This demonstrates good faith, tends to speed up the handling of claims, tends to reduce the involved damages, and, finally, tends to reduce court action.

2. Pay only what is owed and no more. There should be no over-payment of claims. This can lead to disastrous results as all claimants will demand the same treatment. Conversely, there should be no under-payment of claims, as such an action would tend to stir up the public and create many unwanted problems.

3. You should be prepared to do for all claimants anything which is done for one claimant. Equal treatment of all claimants is essential when dealing with masses of people.

4. There must be complete fairness, honesty and consideration of all claims. When one deals with masses of people, one has to consider all of their problems.

5. Never become involved in politics. Frequently during a spill, people come to claims adjusters with very bad attitudes; they may want to scream and yell at somebody. We try to avoid getting involved because this will not solve the problems of adjusting the claim.

6. There must be positive identification of all of the claimants. We have often dealt with people who were trying to collect for damages to such things as pleasure boats when in fact they did not even own the boat. Another example of this type of situation resulted in a major West Coast spill where considerable amounts of clothing were totally damaged. This clothing was promptly and properly paid for and the claimants were allowed to take back the clothing, allegedly to destroy the damaged property. In many instances, we found that several weeks later the same clothing would reappear in the hands of new claimants. As a result of this type of action, it was necessary after settlement to keep all totally destroyed clothing and then to dispose of it ourselves. In summary, before compensation is paid for any damage, special effort must be taken to make certain that only the owner of the involved property is paid. We might add that methods have been developed which can identify the type and origin of oil on a boat, clothing, etc. and by utilizing these methods, improper claims can be avoided. This type of system has allowed us to eliminate the claims of persons who rubbed their clothing in street oil and then presented the articles of clothing as oil spill related damage.

7. All complaints or claims must be checked out regardless of how small or insignificant they might seem. In this way complete overall fairness to the public, which will result in good will, is practiced.

8. There must be complete communication with the public. In major spills, we find that the public is clamoring for answers regarding what is going to be done about their damaged property. Rather than allowing hundreds of phone calls to come in, we find it extremely beneficial to meet with various groups such as homeowners associations, boat owner associations, etc., and in this way a system of communication can be established.

ROLE OF THE COORDINATOR:

We have found that there are four distinct, concurrent efforts operating during an oil spill which generate from the spiller or his representative. These would involve cleanup, claims, legal and public relations. All of these elements are vitally important considerations, and each must be handled properly if the best overall results are to be received by both the spiller and the public. If these elements are not closely coordinated or if they go their own direction without considering the other elements, serious unwanted problems can result.

It has become very apparent that it is of major importance to have an oil spill coordinator to make certain that all elements of oil spill handling are properly working together in a positive and fruitful manner.

PERSONNEL ADJUSTING:

Considering the political and economical impact of an oil spill, we feel that only the most experienced personnel should be utilized. Improper handling of oil spills could result in the creation of a class action. Adjusters or firms having prior experience in oil spills or class action related oil spills should be utilized. There is a definite specialty in handling major oil spills which is over and above normal insurance adjusting procedures. Generally, it could be stated that it is far better to over-react then to under-react in order to properly deal with the explosive issues at hand.

DAMAGE ASSESSMENT:

From a damage assessment standpoint, we are faced with four basic types of damages. There is a different approach to each type of damage.

1. Non-existent or fraudulent claim — we find that when dealing with a major spill, a certain number of claims will fall under this category. There seems to

always be a certain number of individuals who will try to take advantage of an existing crisis.

2. **Real physical damage** — this type of damage results from direct contact of oil on all types of property. Included in this type of damage would be private vessels, fishing vessels, clothing, etc.

3. **A combination of real damage and nebulous damage** — included in this group would be the alleged loss of current business income of fishermen, restaurants, hotels, motels and various other business income losses. Also included in this group would be the rental loss related to beachfront homes.

4. **Nebulous damage** — this would include alleged losses such as future income, loss of property value, etc.

All of these damage claims must be dealt with, and the following ways of dealing with the claims are recommended.

1. **Non-existent or fraudulent claim** — these claims should be denied since they have no legal status. If this type of claim is paid, it would only encourage others to make fraudulent claims. We have found that even people with legitimate claims will get stirred up if they hear that a claim has been denied. Therefore, it is highly recommended that the denial of this type of claim be delayed until all legitimate claims are resolved.

2. **Real physical damage** — appraisals or verification of loss by the adjuster will take care of this type of damage. The claims adjuster should be able to write his own marine appraisal as this will allow a prompt and efficient resolution of the claim.

3. **Real damage and nebulous damage combination** — the books and records of hotel and motel owners can be checked to calculate the loss of income. The figures arrived at through proper accounting methods do not always reflect the true loss. There are often outside nebulous factors which effect what the true loss might be. Some of the nebulous factors might be extremely bad weather, new competition and, possibly, the presence of other pollutants which might have acted without the presence of an oil spill to reduce the business income. These factors must also be considered when adjusting a claim. We have found that in some cases, an oil spill is used as an excuse to write off business losses not directly connected to the spill.

This is the most controversial area of damage assessment. The loss of future income is included in this category. We have found, in covering many oil spills, that future income is rarely affected by a spill. There may be a temporary loss of value to beachfront property during the actual length of the oil spill. We have seen, however, that in the long run, property values are not affected. This is illustrated by the fact that the tax assessors usually refuse to reduce the property taxes on beachfront property after a spill. Highly qualified experts in the field of science, economics, real estate, etc. should be utilized to aid in determining if damage exists. Finally, common sense and compromise is highly suggested in this area of nebulous damage.

CONCLUSION:

There has been a considerable amount of contingency planning related to the prevention and cleanup of oil spills. It is also imperative that contingency planning relating to the handling/adjustment of claims be accomplished so that this important function of an oil spill can proceed in a prompt and fruitful manner.

I would like to reiterate that complete fairness is necessary in the adjustment of oil spill claims. We have found that industry is in complete agreement with this approach. More than ever before, government, ecologists, industry, and other concerned organizations and individuals must work together in the problem areas of oil spills. If voluntary cooperation can be obtained between these organizations and individuals, perhaps we can have both the energy our nation needs and the ecology which our nation wants.

V. SYSTEMS, ECONOMICS, AND POLITICAL SCIENCE APPROACHES

INTRODUCTION

Many of the previous speakers at the symposium had expressed a need for methodologies to assess the social impacts of oil spills. The fifth session presented three such methodologies: systems analysis, economic techniques, and political science approaches.

The discussion of accurate assessment began with Joseph Pizzo's discussion of a systems analysis approach. Pizzo, of the Oceanographic Institute of Washington, explained that since systems analysis can provide methodologies for ordering complex systems, it can be of value in handling several aspects of the oil spill problem. Fault trees can be used to establish cause and effect relationships. Then, a risk model analysis can be undertaken to determine what subsystems are at fault and what could be done to correct them to minimize the impacts of oil spills. The audience expressed interest in one particular aspect of the Fault Tree technique — the insertion of numeric inputs. One way of finding such data could be to use the Delphi method whereby a group of experts are assigned to develop a rating system. The Delphi method was discussed by the group and seen as a possible method for assigning some values to noneconomic considerations. There was general discussion on the necessity of affixing dollar values to all impacts. The question was again raised as to whether we could find a way of measuring the economic value of one lost day of swimming at a beach.

Dennis Tihansky, of the Implementation Research Division of EPA, answered this question in the affirmative. He described eight theoretical techniques within economics that could be used for measuring the cost of pollution damages. After some of the difficulties of the empirical application of these techniques were discussed, it was explained that empirical techniques must be applied selectively to specific water uses. For example, recreation damages should be assessed using consumer surplus or willingness-to-pay concepts. Keeping this prescription in mind, Tihansky informed the participants that economic estimates of damages can and have been given. He concluded by stating that economics can provide at least the beginnings of a systematic assessment approach by helping to answer the question most often asked by decision-makers and the public, "How much is it costing us?"

Even when the economics are known, assessing the social impact of an oil spill cannot be accomplished without a preliminary understanding of what the term "social impact" means. The participants had heard explanations of ecological, legal, mathematical, and economic assessments. Thomas Cook and Frank Scioli introduced the role of the political scientist as an assessor of damages. They suggested that the problem of assessment from the viewpoint of the social sciences was primarily that of developing workable methodologies having adequate measurement, design, and analysis components. They also stressed the importance of adopting measurement techniques that would allow others to replicate the research; i.e., the method used to assess the damage in Santa Barbara should be the same as the one used in New Orleans. They reminded the participants that the development of systematic techniques for analyzing the social impacts of oil spills is impeded by factors of time, cost, and autonomy. The role of the researcher, they concluded, cannot be influenced by governmental pressure to arrive at "the right answers."

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THE APPLICATION OF SYSTEMS ANALYSIS TECHNIQUES TO SOCIAL IMPACTS DUE TO OIL SPILLED IN THE MARINE ENVIRONMENT

JOSEPH PIZZO

Research Investigator,
Oceanographic Institute of Washington

I would like to discuss in general terms a systematic approach for analyzing the social impact from oil spillage. First, let me qualify my remarks by stating that I am not a sociologist or an economist but a mathematician by training and am involved in applying systems analysis techniques to ecological problems. Second, I have come to this symposium with no solutions to offer but rather an approach. I would like to suggest that if we are going to investigate a problem of this complexity, a problem containing such a large number of parameters and interacting forces, we need to devise some kind of conceptual framework.

When we think of systems analysis, the words "mathematical modeling," "optimization techniques," "computer simulation" come to mind. These terms inevitably turn some people off and the question usually arises, "What does this have to do with the real world?" It has a great deal to do with the real world because systems analysis provides powerful methodologies for ordering complex systems and putting what seems like extraneous information into a workable form. Once this is done, we are able to examine the data, to re-evaluate our investigation, and, most importantly perhaps, to learn the right questions to ask. The process involves designing a flow chart of information such as the flow chart provided in the pre-conference readings and relating all the parameters to determine the cause and effect relationships. We will come up with certain answers, and if these answers seem disconcerting to us, we can look at our errors and come up with new answers. This feedback loop is very important for the analysis to be a dynamic process.

I would like to begin the approach to investigating the social impacts of oil spills by suggesting three goals for analysis. I hope that we can all agree that we are interested in finding ways to prevent oil spills, to minimize their damage, and to minimize the effects their consequences will have on any given community. The most popular way of regarding the problem might be to say, "On the one hand, we have an obvious need for petroleum products and ecosystems are so resilient that after a spill, restabilization will occur. Therefore, the benefits exceed the costs. On the other hand, the damages done are often irreparable and therefore, the costs exceed the benefits." Neither of these approaches is entirely satisfactory. I personally cannot imagine a spill occurring in any area that would be so damaging as to prevent me from living there. Life might be very unpleasant and, perhaps, very costly, but I think it is important to remember that when we talk about risks, we are talking about the levels of risk. There is no such thing as a zero risk involved in an oil transportation situation unless we simply eliminate the presence of the oil. The ultimate question thus becomes, "What is the acceptable level of risk I can endure for the amenities oil provides?"

Although I have no answer to this question, I would like to mention one approach taken by Chauncey Starr in his paper "Benefit-Cost Studies in Socio-Technical Systems." Starr took a look at the historical data on accidental fatalities in certain categories and related the figures to the general population in terms of exposure hours. He thus provided us with a nondimensional view of how accidents relate to each other. In 1965 for example, there was one fatality for tanker accidents in over 700 exposure hours or .0014 people per one exposure hour. Since the yearly total for motor vehicle accidents is 104 fatalities per exposure hour or 150,000 a year, we might conclude that the risk resulting in tanker accident deaths is minimal. But there is a more significant aspect to the risk resulting from a tanker accident than the number of persons killed. It is the consequential effects on the community from the spillage of the oil. Thus we need to translate and determine the risks to the community at large: the populations at risk, the properties at risk, the systems at risk, and the environment at risk as shown in Figure 1. And we should also remember that when we talk about risks, we are talking about either voluntary or nonvoluntary risks. We can establish risk levels for acci-

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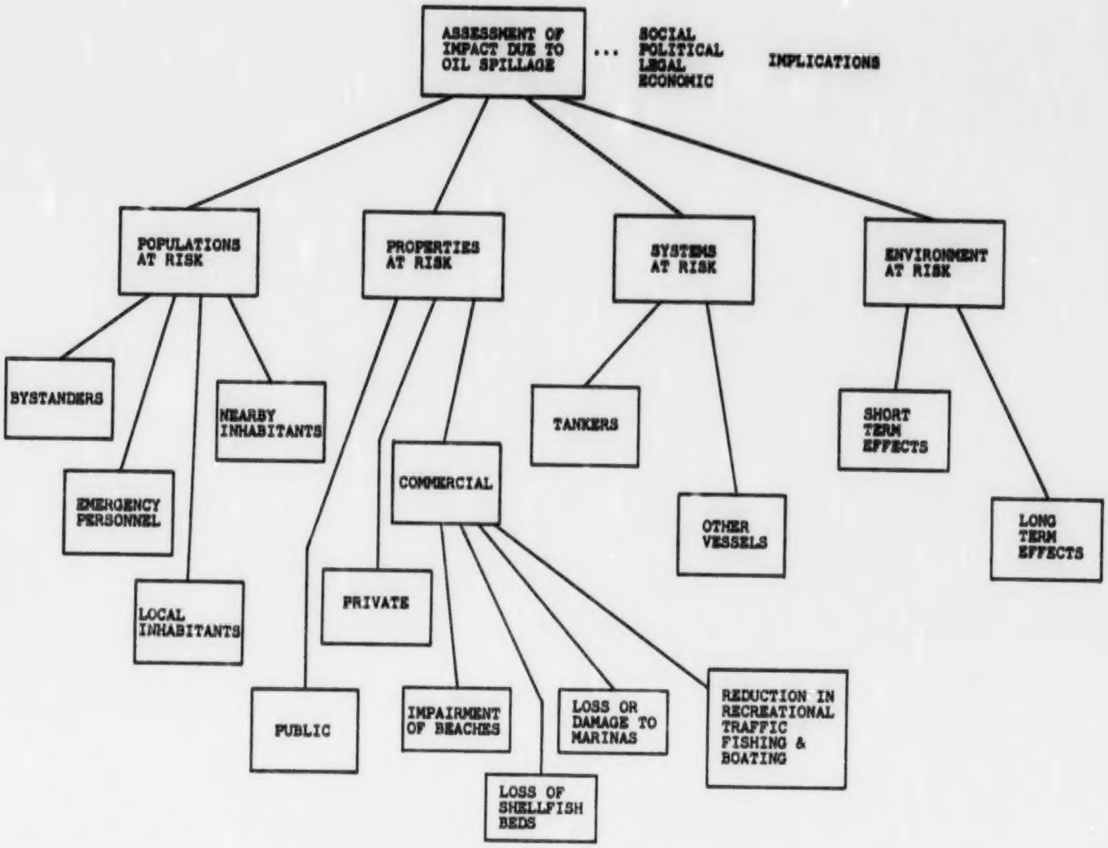

ASSESSMENT OF IMPACT DUE TO OIL SPILLAGE
...
SOCIAL
POLITICAL
LEGAL
ECONOMIC
IMPLICATIONS
POPULATIONS AT RISK
PROPERTIES AT RISK
SYSTEMS AT RISK
ENVIRONMENT AT RISK
BYSTANDERS
EMERGENCY PERSONNEL
LOCAL INHABITANTS
NEARBY INHABITANTS
PUBLIC
PRIVATE
COMMERCIAL
IMPAIRMENT OF BEACHES
LOSS OF SHELLFISH BEDS
LOSS OR DAMAGE TO MARINAS
REDUCTION IN RECREATIONAL TRAFFIC FISHING & BOATING
TANKERS
OTHER VESSELS
SHORT TERM EFFECTS
LONG TERM EFFECTS

Figure 1. Assessments of impacts due to oil spillage.

dents in such diverse areas as disease, skiing, and nuclear power plants. If we could use this approach to establish a risk level for oil spillage we might have some way of making comparisions, of estimating the costs to the individual and to the community.

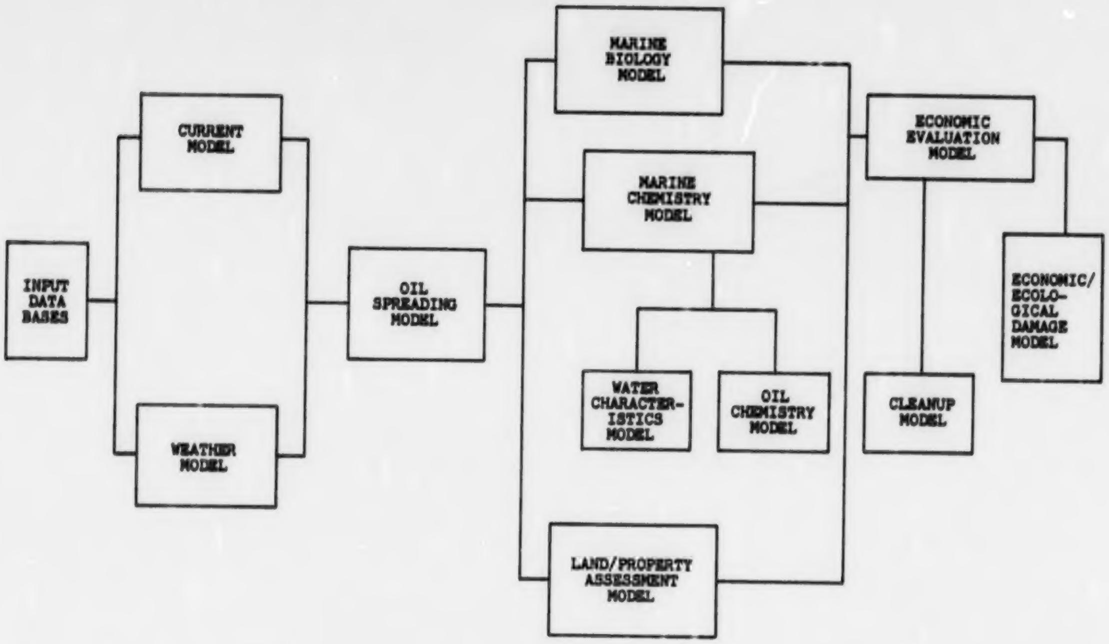
Our talk about risk analysis is an attempt to find a way of measuring and evaluating the social impact of oil spills. We have had a discussion on the economic costs which can be evaluated. I would like to suggest that in addition to evaluating the replacement/restoration costs we consider these other measures, all of which are indirectly economic: aesthetic inconvenience, health hazards, damage to recreational capabilities, and the overall productivity of the community.

The Oceanographic Institute of Washington (OIW) report, *Risk Analysis of the Oil Transportation System*, suggests an economic model to evaluate the damages of an oil spill. Figure 2 illustrates this assessment model with a data base including biological, chemical, and land assessment information, and cleanup costs. The model can be used in the abstract by creating scenarios, or it can be used in real time by helping those who are monitoring a spill to know where the spill can go and how much it will cost to clean it up. For example, suppose a spill was spreading to one of two areas — a deserted beach or a shellfish bed — and an immediate decision had to be made concerning which direction the available booms could force the oil to move to, if it could be contained. A fast answer would be needed and one way to go about it would be to have a computer program working in real time assessing the damage to each area.

A generalized framework for analyzing any problem using systems analysis techniques would go something like this. First, you would look at the historical data, then perform a statistical analysis, define the parameters, where possible, and employ risk model analysis. When we are dealing with a vast number of parameters, it is essential to try to extract the parameters that are actually perturbing the system. With these parameters, we can measure the severity factor and develop a systems performance model. Then we can simulate the model on the computer and examine what is taking place in terms of the physical phenomena. If the system works and the model is representative, we can go on to find ways of improving conditions to arrive at an acceptable level of risk. If the model is not representative, we must go back and check our information and repeat the iterative process.

The Oceanographic Institute of Washington completed (the initial phase of) a study of oil transportation and handling on Washington waters. The framework for this analysis appears in Figure 3. We were trying to set up a continual risk analysis program that would identify potential problem areas, evaluate damage and help to make the right decisions to minimize risk to the region. We did learn that even from this first cut, valuable information can be gathered. We recommended that since maneuverability through the Rosario Strait was one of the main problems and that since certified pilots had to be available at all times to do this navigation, pilots should have:

Figure 2. Ecological model – economic deficits as a function of ecological damage.


INPUT DATA BASES
CURRENT MODEL
WEATHER MODEL
OIL SPREADING MODEL
MARINE BIOLOGY MODEL
MARINE CHEMISTRY MODEL
WATER CHARACTERISTICS MODEL
OIL CHEMISTRY MODEL
LAND/PROPERTY ASSESSMENT MODEL
ECONOMIC EVALUATION MODEL
CLEANUP MODEL
ECONOMIC/ ECOLOGICAL DAMAGE MODEL

1) rest periods between assignments
2) a choice of refusal to pilot vessels on the grounds that vessel is uncertified for such passage
3) a program of physical fitness and educational training
4) tug boat assistance for vessels over 50,000 dwt.

These recommendations were forwarded by the legislature to the State Board of Pilotage Commissioners which accepted the first three recommendations but withheld acceptance of the fourth due to questions of its legality.

This example illustrates how a systematic analysis of the problems can provide some tangible results. We know that oil spillage from vessels occurs primarily through collisions and groundings and that 70 per cent of these accidents can be attributed to human error. Using risk analysis we could not only consider the consequential effects after a spill had occurred, but could also determine what the cause/effect relationships leading up to these errors are.

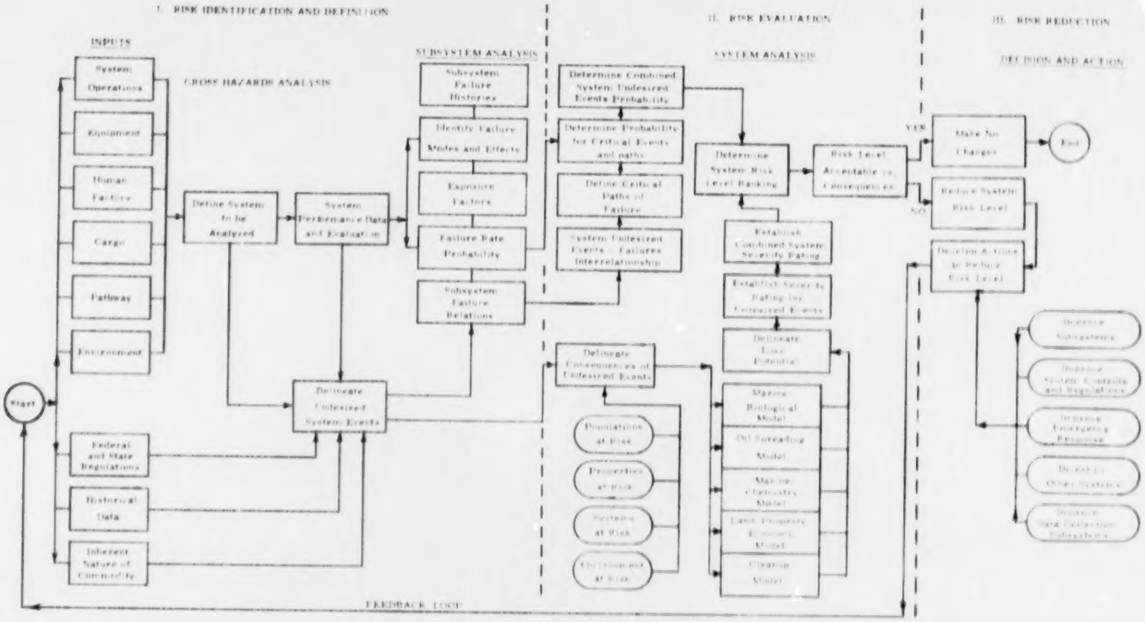
One very effective technique for establishing cause/effect relationships is called Fault Tree analysis. It is basically a logic tree. This technique requires properly relating all possible sequences of events that can result in an undesirable top event, filtering down to a multitude of lesser events that can cause the top event to occur. For example, we can start by saying that we don't want an oil spill to occur and we can find out all the contributory events that can make it occur.

The events are interconnected by means of logic gates relating basic causes with end events. The three basic logic gates are the "or" gate (meaning that at least one of the input events occurs), the "and" gate (all input events must occur), and the conditional inhibit gate (that says the fault sequences can occur only when certain conditions are met).

Using the Fault Tree technique, a risk model analysis would enable us to determine and show a way of correcting the subsystems at fault. (A full risk model analysis appears in Figure 4.)

By inserting numeric inputs for the end events in the form of a probability, a numeric rating for each gate and associated event can be obtained. The numerics for the end events can be historical data or some definitive information obtained by mathematical models. In the case of unquantifiables such as aesthetics, we can use the Delphi method of assigning a group of experts to define a rating system.

Figure 3. Framework for analysis.


I. RISK IDENTIFICATION AND DEFINITION
INPUTS
GROSS HAZARDS ANALYSIS
SUBSYSTEM ANALYSIS
II. RISK EVALUATION
SYSTEM ANALYSIS
III. RISK REDUCTION
DECISION AND ACTION
System Operations
Equipment
Human Factors
Cargo
Pathway
Environment
Start
Federal and State Regulations
Historical Data
Inherent Nature of Commodity
Define System to be Analyzed
System Performance Data and Evaluation
Delineate Undesired System Events
Subsystem Failure Histories
Identify Failure Modes and Effects
Exposure Factors
Failure Rate Probability
Subsystem Failure Relations
Determine Combined System Undesired Events Probability
Determine Probability for Critical Events and paths
Define Critical Paths of Failure
System Undesired Events — Failures Interrelationship
Delineate Consequences of Undesired Events
Populations at Risk
Properties at Risk
Systems at Risk
Environment at Risk
Determine System Risk Level Ranking
Establish Combined System Severity Rating
Establish Severity Rating for Undesired Events
Delineate Loss Potential
Marine Biological Model
Oil Spreading Model
Marine Chemistry Model
Land Property Economic Model
Cleanup Model
Risk Level Acceptable vs. Consequences
YES
NO
Make No Changes
End
Reduce System Risk Level
Decision Actions to Reduce Risk Level
Improve Subsystems
Improve System Controls and Regulations
Improve Emergency Response
Interface Other Systems
Improve Data Collection Subsystems
FEEDBACK LOOP

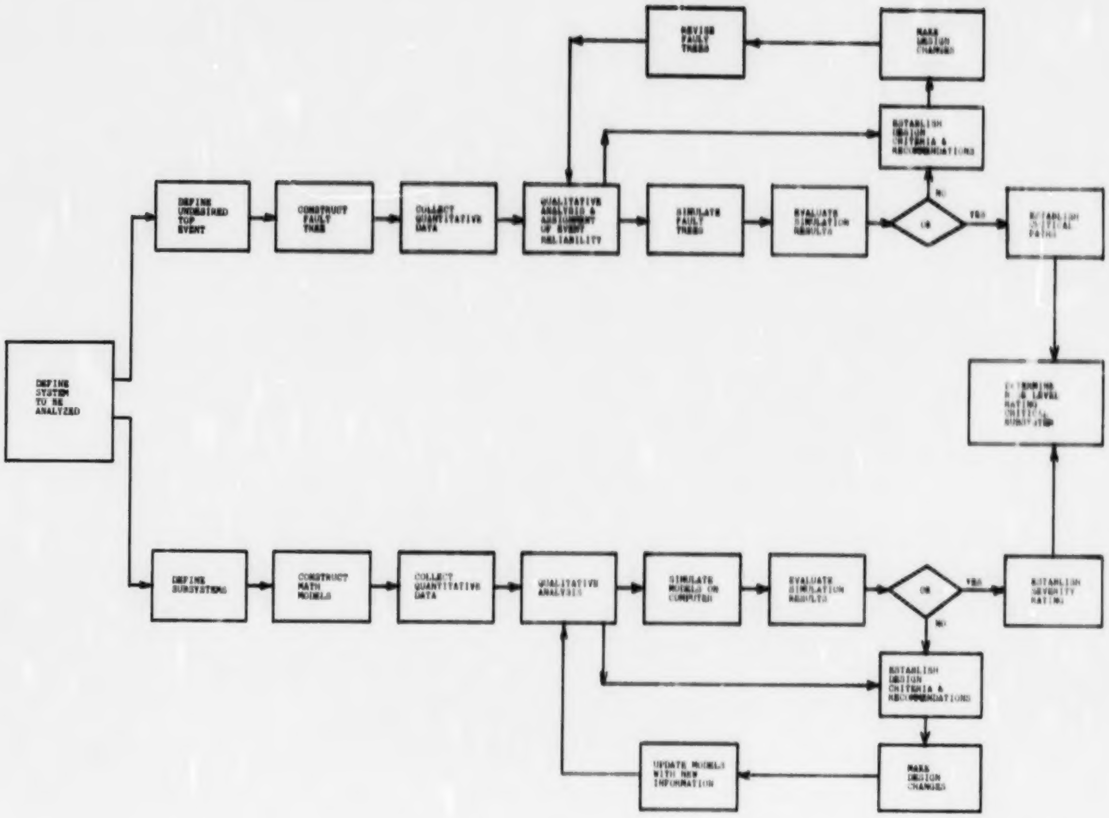

DEFINE SYSTEM TO BE ANALYZED
DEFINE UNDESIRED TOP EVENT
CONSTRUCT FAULT TREE
COLLECT QUANTITATIVE DATA
QUALITATIVE ANALYSIS & ASSIGNMENT OF EVENT RELIABILITY
SIMULATE FAULT TREES
EVALUATE SIMULATION RESULTS
OK
NO
YES
ESTABLISH CRITICAL PATHS
ESTABLISH DESIGN CRITERIA & RECOMMENDATIONS
MAKE DESIGN CHANGES
REVISE FAULT TREES
DETERMINE RATING CRITICAL SUBSYSTEM
DEFINE SUBSYSTEMS
CONSTRUCT MATH MODELS
COLLECT QUANTITATIVE DATA
QUALITATIVE ANALYSIS
SIMULATE MODELS ON COMPUTER
EVALUATE SIMULATION RESULTS
OK
YES
NO
ESTABLISH SEVERITY RATING
ESTABLISH DESIGN CRITERIA & RECOMMENDATIONS
MAKE DESIGN CHANGES
UPDATE MODELS WITH NEW INFORMATION

Figure 4. Risk model analysis.

The procedure for analyzing the Tree employs Monte Carlo simulation by which the critical paths are determined, showing what subevents are the prime causes of the top event. By comparing some computed intermediate event values with historical data, where available, we can determine how valid our cause/effect logic is for that segment of the Tree. Consider Tree analysis as dynamic where we can explore "what if" situations and continually update our data and logic until we satisfy the real world we are attempting to simulate. The very act of diagramming these events in a pattern of causal relationships will increase our understanding of the system. The Fault Tree method can take a complicated system and reduce it to simple pathways that can be explored further. Figure 5 gives an example of a Fault Tree used in the OIW study *Risk Analysis of the Oil Transportation System.*

The primary significance of this technique can be seen when we look at historical events. So often decisions have been addressed to problems that were not on any critical contributory path to a particular event. If a Fault Tree had been used, if a clear understanding of the true cause and effect relationship had been reached, the solutions would have corresponded to the problem. When we think of the social impact of oil spills, we must remember that we are trying to determine what the acceptable level of both economic and ecological costs and aesthetic inconvenience. All of these areas produce emotionally charged responses. I suggest to you that if we can stand back a bit and get an objective look at this very complicated problem, we can begin to quantify the "unquantifiable." Certainly, risk model analysis, using Fault Trees, can provide us with a meaningful framework for this assessment.

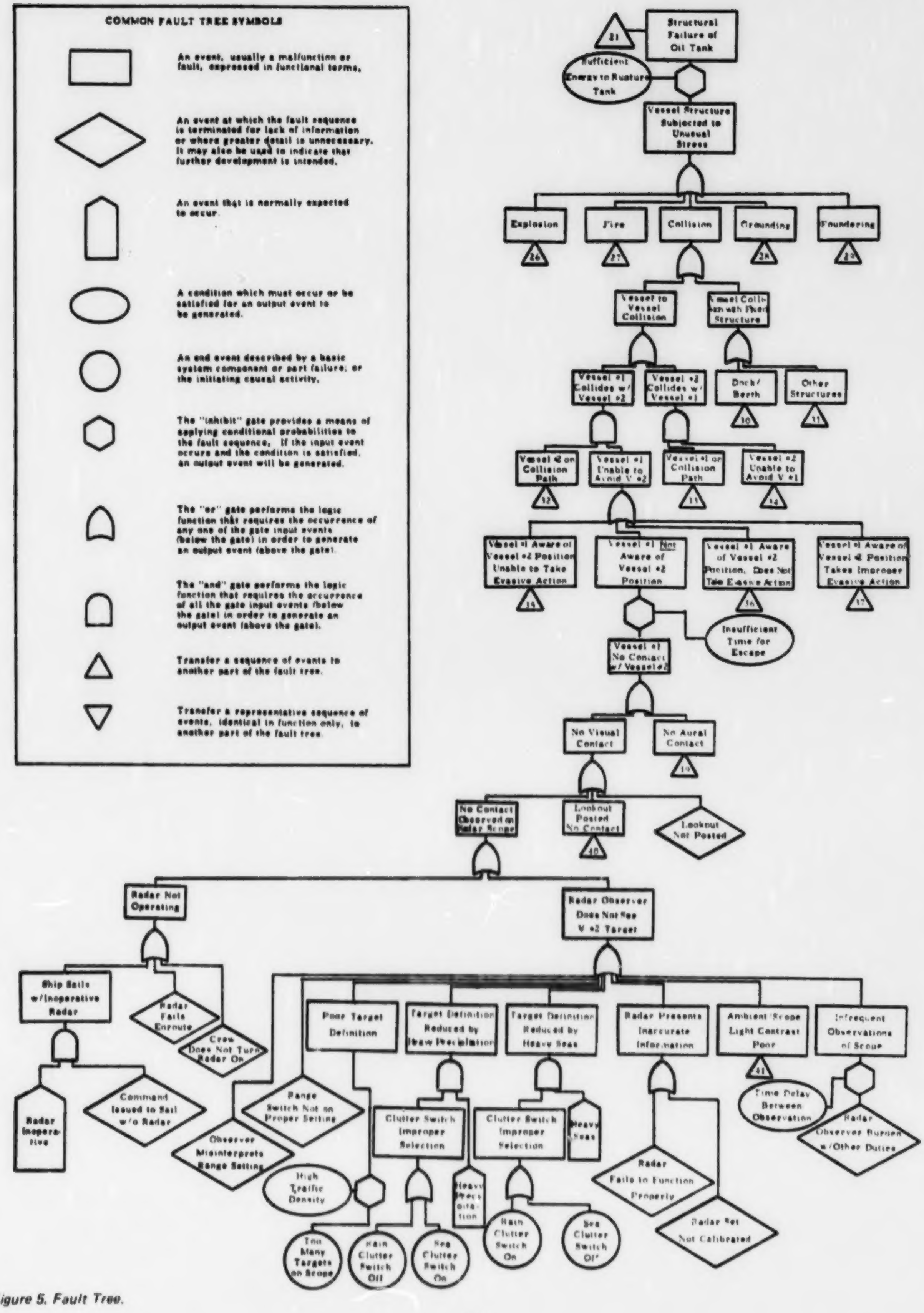

COMMON FAULT TREE SYMBOLS
An event, usually a malfunction or fault, expressed in functional terms.
An event at which the fault sequence is terminated for lack of information or where greater detail is unnecessary. It may also be used to indicate that further development is intended.
An event that is normally expected to occur.
A condition which must occur or be satisfied for an output event to be generated.
An end event described by a basic system component or part failure; or the initiating causal activity.
The "inhibit" gate provides a means of applying conditional probabilities to the fault sequence. If the input event occurs and the condition is satisfied, an output event will be generated.
The "or" gate performs the logic function that requires the occurrence of any one of the gate input events (below the gate) in order to generate an output event (above the gate).
The "and" gate performs the logic function that requires the occurrence of all the gate input events (below the gate) in order to generate an output event (above the gate).
Transfer a sequence of events to another part of the fault tree.
Transfer a representative sequence of events, identical in function only, to another part of the fault tree.
21
Structural Failure of Oil Tank
Sufficient Energy to Rupture Tank
Vessel Structure Subjected to Unusual Stress
Explosion
Fire
Collision
Grounding
Foundering
26
27
28
29
Vessel to Vessel Collision
Vessel Collision with Fixed Structure
Vessel #1 Collides w/ Vessel #2
Vessel #2 Collides w/ Vessel #1
Dock/ Berth
Other Structures
30
31
Vessel #2 on Collision Path
Vessel #1 Unable to Avoid V #2
Vessel #1 on Collision Path
Vessel #2 Unable to Avoid V #1
32
33
34
Vessel #1 Aware of Vessel #2 Position Unable to Take Evasive Action
Vessel #1 Not Aware of Vessel #2 Position
Vessel #1 Aware of Vessel #2 Position, Does Not Take Evasive Action
Vessel #1 Aware of Vessel #2 Position Takes Improper Evasive Action
35
36
37
Insufficient Time for Escape
Vessel #1 No Contact w/ Vessel #2
No Visual Contact
No Aural Contact
39
No Contact Observed on Radar Scope
Lookout Posted No Contact
40
Lookout Not Posted
Radar Not Operating
Radar Observer Does Not See V #2 Target
Ship Sails w/Inoperative Radar
Radar Fails Enroute
Crew Does Not Turn Radar On
Radar Inoperative
Command Issued to Sail w/o Radar
Observer Misinterprets Range Setting
Range Switch Not on Proper Setting
Poor Target Definition
Target Definition Reduced by Heavy Precipitation
Target Definition Reduced by Heavy Seas
Radar Presents Inaccurate Information
Ambient/Scope Light Contrast Poor
41
Infrequent Observations of Scope
Clutter Switch Improper Selection
Clutter Switch Improper Selection
Heavy Seas
High Traffic Density
Heavy Precipitation
Time Delay Between Observation
Radar Observer Burden w/Other Duties
Radar Fails to Function Properly
Radar Set Not Calibrated
Too Many Targets on Scope
Rain Clutter Switch Off
Sea Clutter Switch On
Rain Clutter Switch On
Sea Clutter Switch Off

Figure 5. Fault Tree.

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ECONOMIC DAMAGES FROM OIL SPILLS: MEASUREMENT TECHNIQUES AND EMPIRICAL RESULTS

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I. THEORY OF BENEFIT EVALUATION

Pollution control yields benefits only if there exists a demand for water uses. For each consumer, the amount that he is willing to pay for incremental controls provides an estimate of personal welfare. Theoretically, the net welfare to society of providing a certain quantity of goods or services is measured as the area bounded by the demand and supply curves. In Figure 1 this area is defined within ABCE. The curve labelled D is the demand and S, the supply schedule. Area BCE is the net benefit to consumers, or "consumer surplus" in economic jargon. Although the market price for the good or service is at point E, some consumers are willing to pay as much as C and hence are benefiting by amount BC. Complementary to this analysis is "producer surplus," depicted by area ABE. Although supplies are selling at price E, some producers are willing to sell at a price as low as A and hence are benefiting by the surplus AB.

The validity of this theoretical framework is based on several restrictive assumptions: a perfectly competitive economy, the absence of real income changes, and negligible externalities or side effects. On the supply side, free access by firms into the commercial fishery market, for example, typically occurs without the competitive (optimal) allocation of resources equated at their marginal values. Marginal costs of production seldom reflect the downstream damages caused by waste discharges or spills. On the demand side, the closure of polluted beaches will free recreation expenditures for the purchase of other services and goods and hence effectively raise demand for substitutes.

For some benefit categories, especially recreation, consumer and producer surplus is an incomplete measure of net welfare gains. The demand curve in Figure 1 is based on current users' preferences, yet there may be other individuals willing to finance pollution control efforts so that the next generation can enjoy the facilities. The portion not included is called "option value," which pertains to the hidden demand of potential consumers or non-consumers.

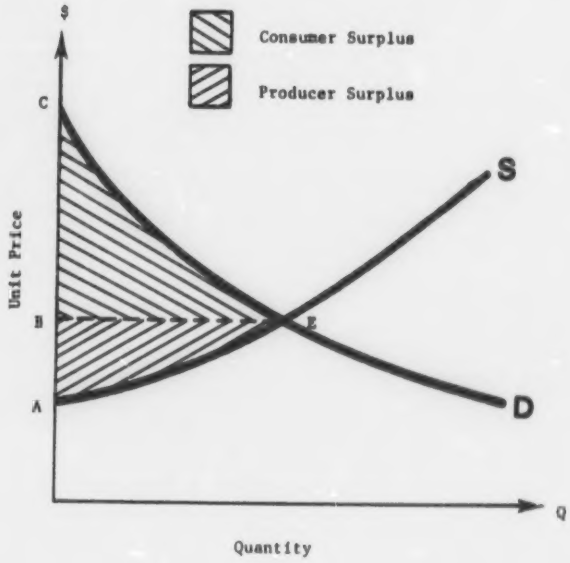

Figure 1. Estimation of social welfare in a demand-supply framework.

In most benefit calculations, either the demand or the supply curve is assumed fixed, while the other curve shifts after water quality changes. The corresponding change in market surplus is a measure of net welfare. For water use categories such that water is a factor of production, water quality enhancement induces a price decrease and hence shifts the supply curve downward, as in Figure 2. Benefits to the consumer are measured as a reduction in expenditures for the original quantity (area ABCE) plus consumer surplus added from the increased demand (area CEF). The supply curve is usually assumed perfectly elastic (horizontal), to avoid the difficulty of estimating

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producer surplus. Benefits most amenable to this type of analysis are water supply treatment for municipalities, industry, and agriculture; domestic water use; and navigation, e.g., harbor maintenance.

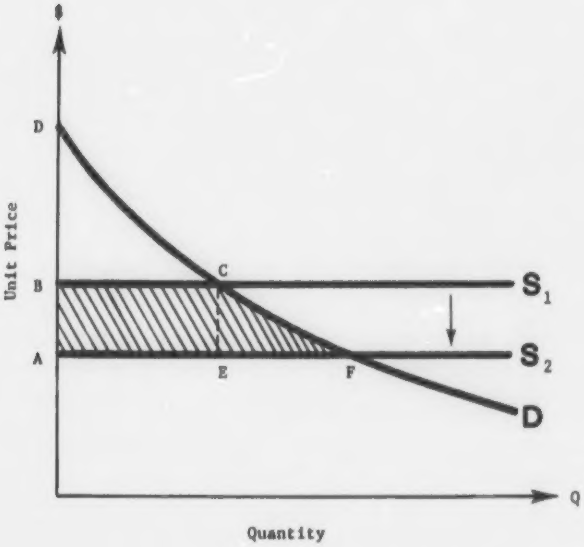

Figure 2. Net welfare gains from a supply shift.

Another approach assumes that demand is infinitely elastic while the supply curve has a positive slope, as in Figure 3. Net benefits equal the area ABCD. To assume that prices remain fixed in a competitive market implies that decisions within individual firms are of minor consequence. That is, supply shifts are small relative to the total output of the economy. This analysis is usually applied to the commercial fishing sector.

For water use categories whose aesthetic attributes depend on water quality, a shift in the demand curve is more appropriate. Consumers are willing to pay more for each quantity of a good or service, according to Figure 4. They also increase total consumption from Q_1 to Q_2 because improved water quality attracts new consumers or else intensifies current demand. Benefits from this approach include recreation and aesthetic appreciation. Land value changes are analyzed in similar fashion, except that the supply curve is assumed vertical (infinitely inelastic) rather than horizontal. As shown in Figure 5, land prices rise from P_1 to P_2 after pollutants are abated.

II. EMPIRICAL TECHNIQUES

Several techniques for estimating damages from oil spills can be applied, the optimal choice dependent upon the water use category and the availability of data. Although some of these techniques are theoretically or conceptually valid, the most widely-used measures are devoid of such rationale. The assumptions underlying each method and empirical problems of estimation are described next.

Costs-of-Control Surrogate

In cases where benefits are not quantified directly, water quality control can be evaluated with respect to incremental costs. In the past it was common to measure costs-of-control as a surrogate for benefits. A qualitative judgment was required to evaluate the net worth of a project. If the costs were not excessive, the project was approved. By circular reasoning, then, any ongoing or past project could always be justified from a cost point of view (Brown, et al., 1964). The possibility of error in this conclusion obviously follows from the lack of information on benefits. Because costs are generally easier to measure than benefits, the popularity of this technique is understandable. Nevertheless, such a surrogate estimate is not implied by theory, nor does it assess values of water use beneficiaries.

Income Accounting

When water quality improvement causes a shift in the supply curve (Figures 2 and 3), the consumer pays less revenue or income for the same quantity of a good or service. The change in total income is a measure of net benefits.

In the case of municipal water supply, the savings in treatment costs are the usual measure of benefits. This technique is valid only if the quality and price of delivered water do not change for the resident. Otherwise, there is also a change in his consumer surplus that must be evaluated. Similar calculations are relevant for industrial water intake, provided that there are neither process nor other internal changes. In agricultural activities, less-contaminated irrigation water increases crop yields or provides the opportunity to grow more valuable, pollution-sensitive crops. Total income must be adjusted by changes in farming expenses as well as federal impacts of price support policies.

In practically all empirical studies of commercial fishing, price is assumed constant as total production increases from cleaner water. This assumption is reasonable if the fishing firm is small relative to the rest of the industry. At least two estimates (Bale, 1971; Council on Environmental Quality, 1970, p. 17), however, assume fixed prices at the national level, thus contradicting empirical formulations of downward-sloping demand (Bell, et al., 1970, pp. 117-129).

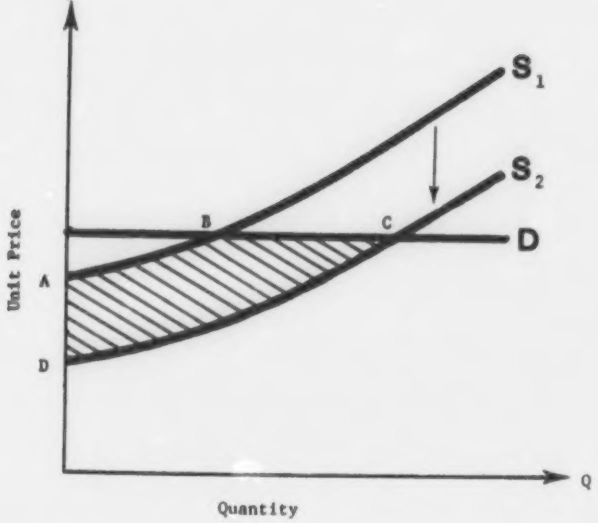

Figure 3. Net welfare gains from a supply shift, at a constant price.

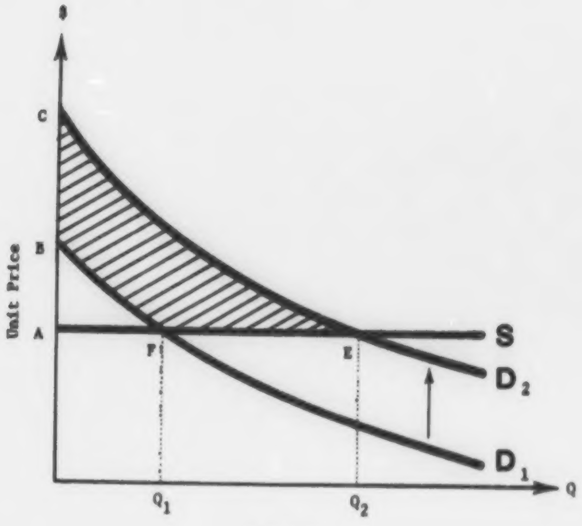

Figure 4. Net welfare gains from a demand shift, at a constant price.

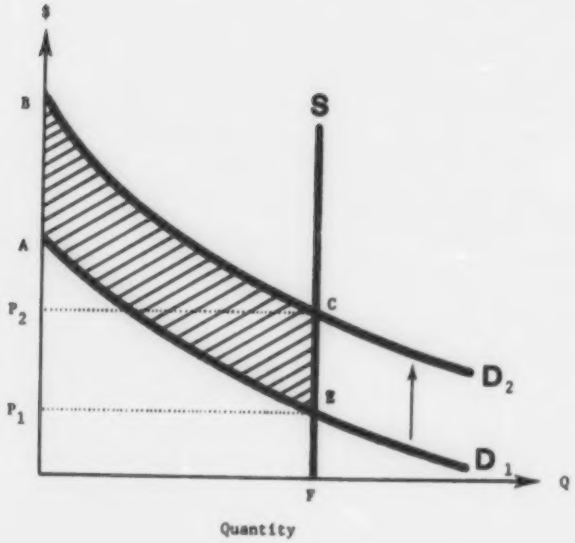

Figure 5. Net welfare gains from a demand shift, at fixed capacity.

Contributions to GNP

Another technique is to estimate the incremental impact of water quality control on the gross national product or perhaps regional income. To do so, it is necessary to trace sectoral dependencies and the flow of output transactions from the original water user to the rest of the economy. Input-output tables reveal the degree of dependence among economic sectors, but they assume fixed values of technical coefficients, which is unrealistic given water quality changes. Moreover, seldom are waste residuals assessed in an input-output analysis, so that environmental attributes would be difficult, if not impossible, to monitor.

A related technique is to apply a regional income multiplier to direct benefits at the water user's site. But this case reduces to the previous analysis since the multiplier equals the sum of input-output coefficients. Because multiplier values are region-specific, they lack sufficient generality for application to other regional studies.

Aside from challenging data requirements of the GNP approach, there are theoretical arguments against its use. Consumer surplus and willingness-to-pay are not valued directly by national income accounts. Only market prices at the intersection (equilibrium) of supply and demand are known. But most waste residual impacts and damages are external to polluters and hence are inadequately valued in the market. In short, GNP measures investment costs rather than the value of public goods, thereby neglecting social benefits.

Expenditures

In the recreation literature the most frequent benefit estimate relies on total expenditures during a typical activity day. A less frequent measure is expenditures less the cost of maintaining recreation facilities. Water quality improvement induces higher participation rates, thus adding more local revenue to the tourist industry. The rationale behind this approach is that expenditures denote what the tourist is willing to pay. There are several fallacies with this logic. Many recreationists are willing to spend more than their current level of expenses. The expenditure method does not measure "the intangible values to the persons enjoying recreation. In the first place, even those expenditures which are over and above normal living costs are not necessarily measures of the recreational enjoyment but are the price paid for certain goods and services for which there are established market values" (Trice and Wood, 1967, p. 200).

The popularity of this method stems from the fact that expenditures data are fairly easy to compile by conducting interviews or surveying the literature. In some studies, total expenses, food, lodging, and travel are added together, while in others especially past studies, only travel costs are assumed. The choice of travel costs as a proxy for benefits follows from well-known studies on travel cost-demand curves (Hotelling, 1949; Clawson and Knetsch, 1966). Whether travel expenses are a good approximation to welfare indices, such as consumer surplus, will be discussed later.

Another application of the expenditures approach pertains to human health losses. The typical estimate of illness includes total medical costs and labor wages lost from absenteeism (Rice, 1965). Unfortunately, medical cost data in public documents are practically non-existent on specific illnesses. Recent criticism by economists points toward the inadequacies of using expenditures and lost income as a proxy for welfare impacts. A better measure, some contend, is the dollar amount that consumers are willing to pay to avoid health risks. But even this is a partial account, since relatives and friends of the affected consumer could also be willing to pay for his protection. Both the consumer's self-interest and society's concern should be considered in the assessment.

Travel Costs

Travel demand at a water body can be measured before and after abatement to assess the changes in travel expenses. To formulate the demand curve, visitors at a recreation site are counted and classified according to their zone of original travel. For each visitor, benefits are measured as the approximate cost of travelling to the site. Of course, travel costs are lower from zones closer to the site, and hence more participants should come from nearby areas. Figure 6 illustrates an example of a travel cost curve, wherein travel expenses are proportional to trip distance. The supply curve is assumed to be a horizontal price line (either at zero price, in this graph, or at a nominal entrance fee).

As water quality improves, more visitors are expected from each travel zone. The resultant rightward shift of the curve from D_1 to D_2 yields net benefits bounded by the two curves. Although this technique at first glance seems theoretically sound, it falls short of empirical meaning for several reasons. First, travel costs are unlikely to reflect real welfare. Some tourists may be willing to pay significantly more than travel expenses to enjoy a site. To differentiate welfare according to distance travelled implies that people living farthest from the site experience the greatest satisfaction. Local residents might derive just as much pleasure from such a visit. Second, this demand analysis is site-specific and cannot be applied to a generalized recreation experience. The exclusion of substitute activities, such as travel to a nearby site, gives at best a partial account of net benefits. Third, the full cost of travel is assumed to be related to the site visitation. Should there be other incentives for the trip, such as the pleasure of driving and sightseeing, only a portion of the costs would be relevant. Just what this portion equals has so far not been assessed in the literature.

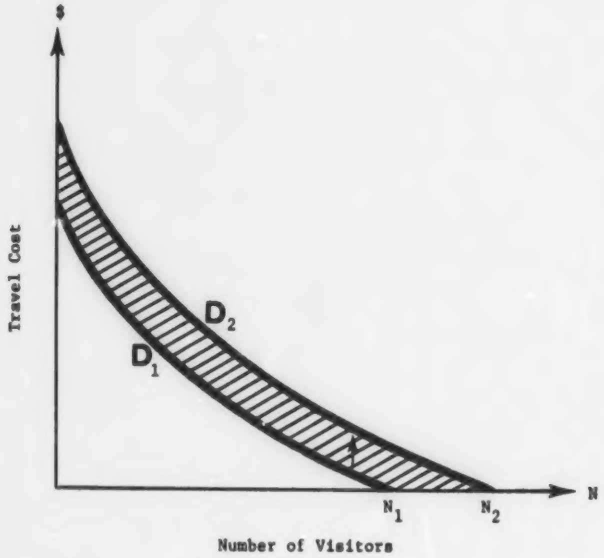

Figure 6. Net benefit estimation from a travel cost model.

Consumer Surplus

From a theoretical viewpoint, the most valid empirical estimates are based on a demand-supply analysis of water uses. In most cases, it is assumed that consumer surplus increases from either a supply or demand shift, holding the other curve constant. The benefits of water quality enhancement are comprised of two elements: (1) income savings and greater satifaction from current demand, and (2) additional consumer surplus realized by the consumption of more goods or services. Few empirical studies, however, are based on this technique, because the derivation of demand functions is complex and requires a large number of data observations. In addition, some economists (Coomber and Biswas, 1972) contend that theoretical assumptions underlying economic estimates, e.g., the lack of externalities in demand shifts, are superficial in the real world.

A few noble efforts toward estimating consumer surplus can be cited in the literature (e.g., Stoevener, *et. al.*, 1972; Reiling, *et al.*, 1973). In at least one study (Stevens, 1966), the concept of consumer surplus is misapplied to give spurious benefit estimates. Figure 7 describes this error of predicting sports fishing benefits from pollution control. The original demand curve, CF, shifts to DG after cleanup. The rectangular area, ABEF, is chosen as the benefit criterion, defined by economists as the maximal revenue earned by a non-discriminating monopolist. In a note of criticism, another theorist (Burt, 1969) argues convincingly that a better welfare measure is net consumer surplus, CDEGF.

Willingness-to-Pay

Related to the concept of consumer surplus is willingness-to-pay. The dollar amount that one is willing to forego for higher quality water may well exceed his current level of expenditures. To extract such information from interviews presents several problems of bias. The respondent may understate his willingness-to-pay if he believes that his answers will affect levels of public expenditure and consequently his tax burden. On the other hand, he is likely to overstate the value if he is assured that no tax burden will result and if he is in favor of strong environmental policies.

To remove the bias problem, economists (e.g., Tideman, 1972, p. 133) have recently proposed the design of questionnaires making the respondent uncertain about the importance of his answers. Although the designs are conceptually interesting, their complexity and misinterpretation of economic terminology may preclude their success in actual situations. Even if they prove to discern responses accurately, the variability of personal opinion over time on such elusive topics as ecological risk may quickly outdate interview findings.

Land Value

Water pollution has been verified in case studies (David, 1968; Dornbusch, 1973) as a significant determinant of property values. The closer land is located to water bodies, the greater is the relative effect on rentals. These observations follow from classical rent theory and thus explain the interest of economists in applying the concepts. But there have been major debates in the literature concerning the sufficiency of the land value technique for explaining welfare impacts. This problem is still unresolved.

There are several difficulties in the assessment of land value changes. Determinants or causal factors of property values are numerous and may be interrelated in a complicated manner. Water quality is but one, albeit an important, factor and is dominated in prediction models by other variables, such as distance of property from the waterfront, zoning restrictions on land development, and the location of property relative to urban or rural sites. Although actual land values should be assessed, such information is usually difficult to obtain. Assessed values, however, are recorded by local governments, and they are often substituted for the actual sales price. Unfortunately, assessment/sales ratios vary in unpredictable fashion, so that the reliability of a proxy value is questionable. Finally, the primary effect of pollution on land sales is observable over the long-run, say, a ten-year period. Accurate, comprehensive records on water quality are of fairly recent origin, and hence the availability of such data from the past is limited to a few regions, such as the Ohio River Basin (ORSANCO, 1950-1973).

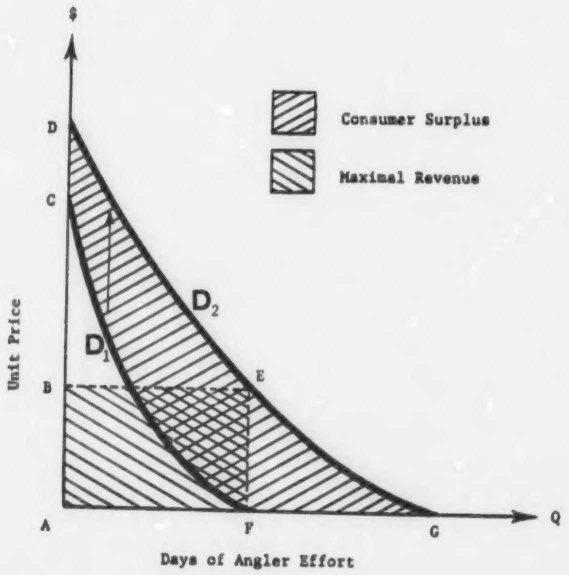

Figure 7. Net benefit estimation of sports fishing demand.

III. ESTIMATES OF OIL POLLUTION DAMAGES

The techniques outlined above can be used to estimate oil spill damages, provided that the effects of oil pollution are distinguishable from those of other pollutants. In most empirical studies, unfortunately, water quality parameters react synergistically or antagonistically to cause economic damages. Only in isolated cases, where oil wastes are the major problem, can such estimates be made with some confidence.

Among the most important criteria for the selection of an empirical technique are relevance to economic theory and applicability to a specific water use. For instance, recreation damages should be assessed by the consumer surplus or willingness-to-pay concepts. Domestic water supply damages, on the other hand, should be quantified in terms of increased household expenditures. If the unavailability of data precludes this conceptual approach, then, and only then, should the empiricist revert to an alternate method, such as expenditures accounting in the case of recreation. The fault with most empirical studies is that they fail to recognize the most theoretically sound methodology.

Economic estimates of actual damages from oil pollution are scattered throughout the literature. Practically all estimates pertain to lost income or expenditures foregone by water users. The U.S. Environmental Protection Agency (Oil and Hazardous Materials Division, 1973) maintains an extensive file on oil spills which have occurred over the past two decades. Each reported incident can include a damage assessment, but a cursory check of the files reveals that fewer than two per cent contain such information. Indeed, most damages were reported as "unknown."

Table 1 presents actual estimates of oil spill damages. Estimates are grouped according to their reference source (respectively, Departments of Interior and Transportation, 1968, p. 4; Oil and Hazardous Materials Division, 1973; Federal Water Pollution Control Administration, 1969, p. 11-464; Yeates vs. Millsaps, 1959; United Nations, 1956, pp. 32-33). The first group refers to potential damages to swimmers from a serious spill during the summer months. These estimates are based on total beach closures and an economic loss of $1.50 per visit. The second group of estimates is compiled from the EPA oil spills file. Fires and explosions from oil leaks result from some of the most costly spills. Following the second group, an estimate is shown from a court case, in which the plaintiff is sued for oil damages. In many hearings, the verdict is "not guilty" because of insufficient evidence on the source or extent of actual damages. Next is an estimate of the replacement costs of waterfowl destroyed by oil pollution in a commercial game area. For each duck, the sales price ranges from $3 to $50, depending on the species. The damage estimate is conservative, as some ducks have no standard market price and are excluded from the calculations. The final set of estimates comes from a United Nations survey of pollution problems.

Of all nations, the Japanese are perhaps most concerned about damages, in addition to removal costs, of oil slicks. Their economy is highly dependent on water resources, with more than 50 per cent of the country's animal protein diet coming from marine life, compared to only 5 per cent in the United States (Anonymous, 1969, p. 321). According to the table, oil pollution substantially reduces seafood and aquaculture yields. Even if the yield remains fixed, sales revenues may decline if the fish have a greasy smell. In Shimozu, Japan, this incident led to a 50 per cent drop of the price for fish in 1955.

All estimates in Table I are based on income or expenditures accounting. This technique is reasonable for the quantification of property and materials damages. However, in the case of recreation losses, the estimates violate theoretical constructs. A better method is to use typical values of a recreation day based on consumer surplus or travel cost. Other estimates subject to debate involve the pricing of nonmarketed goods. For instance, to impute a value of sea birds or other marine life runs counter to frequent opinion that the conservation of nature is an end in and of itself.

In the literature there is only one fairly comprehensive estimate of marine pollution damages (Tihansky, 1973). Annual values totalling approximately $100 million are calculated for recreation, commercial fishing, and navigation (harbor accidents) losses. These estimates exclude indirect or secondary impacts and are based on a general water quality index aggregated over all pollutants. The specific impact of oil spills cannot be assessed from these calculations, although oil certainly affects all of these water uses.

Most published damage estimates are conservative because of the nonquantifiable nature of some neglected impacts. Ecological systems are perturbed, and entire communities of aquatic life species (flora or fauna) may be annihilated. Waterfowl or fish kills are difficult to monitor accurately. Researchers (Ketchum, 1967, pp. 1-3) have concluded that most oil pollutants, e.g., crude oil, persist for months on the ocean surface and can be transported large distances by winds and currents. But damage estimates usually pertain to direct or immediate outcomes.

From an economic viewpoint, the most important damages are not always those measurable immediately after an oil spill. For example, in the commercial fisheries sector, a decline in catch may occur after disruption of the food chain. But according to a marine biologist (Iversen, 1967, p. 1):

> The greatest problem may be the toxic effects on the intertidal animals that serve as food for the other more important fishes. . .the effect is not merely that of killing large populations of commercial fish. Worse than that, it interrupts the so-called food chain.

Because tiny food organisms are generally more sensitive to oil accumulation than fish, more studies should be directed toward the assessment of these damages.

IV. MULTIDISCIPLINARY FRAMEWORK

From previous remarks it is obvious that an economic analysis of damages understates the actual value. There are ecological and aesthetic aspects of oil spills that often defy monetary evaluation. It is likely that the economic counterpart of such aspects will always remain nebulous, as they are not directly responsive to market transactions and the competitive

TABLE 1.
ECONOMIC DAMAGES FROM OIL-RELATED SPILLS

Location	(Date)	Incident (Waste Load)	Damaged Item	Value
Long Island, N.Y.	(?)	Potential Oil Pollution	Recreation Beach	$30,000.000
Los Angeles, Calif.	(?)	Potential Oil Pollution	Recreation Beach	51,000,000
Eugene Island, La.	(1972)	Oil Fire (25,200 gal)	Total Impact[a]	14,000,000
Block Island, R.I.	(1970)	Oil Barge Spill	Recreation Beach	30,000[b]
Drakes Bay, Calif.	(1970)	Wood Preservative Spill (40 gal)	Shellfish	10,000
Kodiak, Alaska	(1970)	Oily Ballast (40,000 gal)	Sea Birds	50,000[c]
Rehobeth Beach, Del.	(1970)	Oil Barge Spill (1,000 gal)	Recreation Beach	40,000[b]
Black Creek, Miss.	(1969)	Oil Refinery Discharge	Sport Fish	20,650
Buzzards Bay, Mass.	(1969)	Fuel Oil (174,000 gal)	Shellfish	28,000
Eureka, Calif.	(1969)	Diesel Fuel (100,000 gal)	Waterfowl	2,500[c]
Louisiana Coast	(1969)	Oil Fire	Total Impact[a]	36,000,000
			Men Killed	600,000[d]
Connecticut Coast	(1961)	Oil Pollution	Waterfowl	100,000
Mississippi Inland	(1959)	Oil Pollution & Fire	Property	7,500
			Cows	1,500[e]
Shimozu, Japan	(1955)	Oil Pollution	Fish Nets	3,000[f]
Hokkado, Japan	(1954)	Fuel Oil (400 tons)	Seaweed	100,000[f]
Tokyo, Japan	(1954)	Light Oil (400 tons)	Shellfish	118,000[f]
Tsukumi, Japan	(1954)	Fuel Oil (60 tons)	Property	32,000[f]
Kamaishi, Japan	(1953)	Fuel Oil	Cultured Oysters	600[f]

[a] Destruction of oil well platform, loss of oil and gas, loss of tourism, and cleanup costs.

[b] Assuming tourist expenditure losses of $20,000 per mile of beach.

[c] Assuming $0.50 per lost sea bird or waterfowl.

[d] Assuming foregone lifetime earnings of $150,000 per man.

[e] Assuming $500 per lost cow.

[f] Converting 500 yen into one U.S. dollar.

pricing mechanism; nor do consumers have a clear, uniform perception of nature's intrinsic values.

Even if all damage recipients could be so evaluated, the choice of a measurement technique is complicated. Theoretically valid methods should be used whenever possible. However, these methods often require large data requirements and are thus infeasible in many quick empirical studies. The use of an alternate method, however, should proceed with the realization that it lacks theoretical justification. Whether the resulting empirical value is close to that obtainable from a theoretically sound approach has never been tested. In some situations, damage estimates accurate to an order of magnitude may be sufficient for environmental policy making. For an illustration, one can refer to a policy recommendation against segregated ballasting by oil tankers, based on an economic cost-benefit analysis (Cheng, 1973, pp. 27-29).

It is incorrect to assume that all damages can be quantified and expressed in monetary terms. Intangible effects, by their very nature, are elusive of simple quantification. In empirical analyses of aesthetics, the usual assumption is quite crude. Monetary damages are first calculated, and a certain percentage of the total is assumed to reflect aesthetic values. This percentage factor is based on "expert judgment," and it often ranges between 60 to 100 per cent (Stone and Friedland, 1970). But such an estimate is obviously biased with subjective opinion. Furthermore, to impute a dollar value on intangibles raises serious objections among those who deny the role of economics in describing nature and those who place an infinite price tag on the environment.

Economics, then, cannot be expected to provide a complete assessment of pollution damages. A more comprehensive approach is required to trace the dynamic impacts of oil pollution. Along quantitative lines, a systems analysis incorporating economic (in particular, monetary) and other components would be useful. A systems viewpoint serves to broaden the perspective of the policy-maker. The choice of optimal strategies for oil wastes control is enhanced by a recognition of cost-benefit tradeoffs among welfare recipients, the environmental habitat, and the original polluter.

Several useful system studies can be cited. Norwegian officials (Nedenes, 1972) developed a regional management model to compare water resources developments with other social welfare programs, such as urban modernization, forest conservation, and agricultural land use. The region of analysis is subdivided into smaller areas, wherein competing water uses are ranked according to "goal preference weights," derived by expert opinions. Then the weights in each area are multiplied by a "goal achievement coefficient," ranging from 0% to 100% of total demand fulfillment. By summing these weighted values for various pollution control strategies, one can relate tradeoffs between human water uses and other environmental goals. Aesthetics and conservation of nature could be integrated into the weighting scheme, but the Norwegians chose to exclude them from the model because of assessment difficulties.

Another model (Stone and Friedland, 1970) incorporates a weighted index of economic and social values of water quality. The formula is expressed as,

$$B_j = W_j^{econ} + y \cdot W_j^{soc}, .$$

where W_j^{econ} and W_j^{soc} are economic and social benefits, each assessed independently by attitude scaling or willingness-to-pay interviews; y is a relative scale combining these benefits; and B_j is a normalized scale of total benefits realized by water use j. This model was used to compare pollution control strategies in San Diego Bay.

A more complex model was designed (Battelle Memorial Institute, 1972) to assess an array of environmental impacts. The model was applied to evaluate water resources planning objectives in the Bear River Basin of Utah. Having multidisciplinary attributes, this model weights environmental damages with and without water pollution abatement. The difference between these damages is the estimate of incremental damages. Impacts in the model are categorized under four headings: ecology, environmental pollution, aesthetics, and human interest (including water uses, health, and culture). In addition, special impacts are flagged if they irreversibly degrade the environment or cause a major shift of resources.

The three models described above illustrate methods of quantifying damages in a comprehensive setting. All of them involve subjective ratings of environmental priorities, and thus are likely to yield biased results. Nevertheless, they attempt to quantify tradeoffs among economic, social, ecological, and other types of values. As benefit measurement continues to progress, comprehensive models should become more popular. Hopefully, economic values will be derived from welfare theoretic notions, which presently is not true with nearly all empirical models, including those cited above.

Finally, it is important to recognize the limitations of welfare economics in the measurement of damages. In the past, a primary goal of water quality management has involved the minimization of total damages to the public. This objective pertains to efficiency of economic resource allocation. But there are also distributional aspects of damages that are generally ignored in welfare theory. That is, one group of water users may be affected relatively more than another. In cases where two water uses, e.g., boating and swimming, are incompatible in the same locality, a priority ranking is necessary. Families earning various incomes tend to respond differently to pollution control policies. The one-man-one-vote ethic is disregarded in willingness-to-pay estimates, wherein the wealthier can afford higher payments. In short, the benefit analysis should be concerned with two economic goals — distributional equity as well as allocative efficiency.

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METHODOLOGICAL AND POLITICAL PROBLEMS INVOLVED IN EVALUATING SOCIAL ACTION POLICY

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Since we are political as well as social scientists, we will try in the following discussion to outline some of the political as well as methodological problems endemic to social action research. We have been primarily involved in program evaluation and, specifically, in the development of methodologies to assess the impact of social programs (especially in the areas of welfare and social justice). We will outline some of the problems we perceive in assessing the social aspects of oil spills and in the governmental and private attempts to, as stated in the pre-conference readings, minimize oil pollution damage. Our discussion will be broken down into two main sections: one dealing with *methodological problems* and the other dealing with the non-methodological, or *political*, problems of social action research, especially as applicable to assessing the social impact of oil spills.

At the outset, we should point out that *systematic evaluation research is still in its infancy*. The attempt to develop methodologies to assess the impact of social programs can range from a program evaluation consisting of a flat statement, "We are doing a great job" to a very elaborate experimental design.

METHODOLOGICAL CONSIDERATIONS

We generally break down a research problem into three main components: first, *measurement;* second, *design considerations;* and third, the *mode of analysis.* We will focus here primarily on the measurement and design components since they are the most germane to the present discussion.

Measurement

There are several questions that seem to be central to the subject of this conference. First, what is a social, political or economic impact? Second, what are the impact indicators which best exemplify these concepts? Third, how do we measure these concepts, and what criteria do we employ to assess the adequacy of our measurement procedures? Finally, how do these impact indicators fit into a model that will assess the impacts of oil spills? Essentially, *we are seeking a theory, or model, of measurement to assess the social impacts of oil spills.*

First, let us address ourselves to the question of measurement and how we assess the adequacy of our measurement procedures. We have selected *five criteria* which may be considered in this regard: the *public* nature of the measurement procedure, *completeness*, *reliability*, *validity*, and *practicality*.

If a measurement procedure is *public*, it can be replicated by any other qualified researcher. For example, if the concept of "fair compensation" is mainly a function of the personal training and idiosynocratic abilities of an individual insurance adjuster, then the measurement procedures used to define this concept are not public, but private. "Public" measurement requires replicability.

If a measurement procedure is *complete*, it samples all the relevant time and space factors of the research problem with the most efficient measurement instruments. The act of measurement is a sampling problem in itself; that is, a sample of behavior is taken at a certain point in time with specific types of instruments by specific researchers. Thus, a measurement procedure is complete only if it gives an accurate picture of all the impacts; a representative "sample" of measurement procedures, times, and behaviors.

A measurement procedure is *reliable* if the methods used can be applied in other places, at other times, by other researchers and produce consistent results. The method used to assess damage in the Santa Barbara oil spill should be consistent with that used in New Orleans. A commonly agreed upon set of criteria should be consistently applied in order to make generalizations to other research settings. There is a *need to develop a theory of data quality control*, especially when assessing aesthetic values, attitudes, opinions, beliefs, motivation, perceptions, in other words, behavior. Such an approach would entail continuous monitoring of the data gathering process to insure the reliability of the procedures, as discussed by R. Naroll (1962) in *Data Quality Control.*

A measurement procedure is *valid* only if it fully represents the impact indicator originally designated in all of its relevant dimensions. In psychometric research, for example, an attempt is made to quantify

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behavior and to represent it in mathematical models. These models are valid only if they can be used to explain and predict behavior. Interdisciplinary studies such as psychometrics may be useful in making the measurement of the social impacts of oil spills more valid by applying a social measurement theory.

Finally, measurement procedures must be feasible and *practical.* It must be possible to apply the procedure. Very often the most complete, reliable, and valid procedure cannot be applied; this leads the researcher to choose one that "satisfices."

Design Considerations

The second subject of consideration in this discussion relates to research design. *We must be able to construct a research design which minimizes the various threats to the validity of our conclusions.* We must determine whether we are studying causal relationships or simply covariate relationships. We must also determine whether we are considering all the possible factors which might have a biasing effect on our results and hence cast doubt on the validity of our conclusions.

It should be recognized that we are discussing two types of validity. *Internal validity* refers to aspects of our research design which might cause us to doubt the conclusions. *External validity* refers to the problem of generalizing the findings of the study to other situations. With regard to research design, we are initially interested in the problems of internal validity. We must establish the validity of the results obtained at a particular point in time before we can (or should) be concerned about the applicability of our conclusions to other research settings. For example, are the cleanup procedures for an oil spill, first, cost-effective as applied at a particular location (internal validity) and, second, applicable to other spill locations (external validity)?

POLITICAL CONSIDERATIONS

We would now like to suggest some of what we consider to be the political obstacles to developing a systematic methodology for evaluating both the impacts of oil spills and the public policy oriented towards preventing oil spills.

The first obstacle is that of *cost.* To develop systematic measurement procedures, there must be a considerable expenditure of resources. Congress has formally charged the EPA with the task of evaluating the impact of oil spills. According to EPA, this charge is backed up for 1973 by only about $2 million. While the objective is a noble one, the mission will go unfulfilled due to a shortage of funds necessary to adequately attend to the task.

The second obstacle is *time.* Time-related obstacles tend to arise when policy-makers demand the quick answers needed to report back to their constituents that a program is achieving its objectives. Program administrators make similar demands in order to make appropriate accountings to the legislatures that authorized the evaluation and granted the funds. Quick answers may not always be possible because many impacts, especially those involving oil spills, can be detected only after the passage of time.

The last obstacle, and one that has been alluded to many times in this conference, is the *autonomy of the social scientist (or any scientist) in evaluating public policy.* This problem was thoroughly discussed in an article by Jeffrey A. Perlman which appeared in the *Wall Street Journal* on September 27, 1973. The article notes that because NEPA required that impact statements be written before a project with potentially detrimental environmental effects can be approved, there has been a scramble for contracts to conduct the research for the EIS's. Many unscrupulous consultants are more than willing to write impact statements tailored to the needs of the client.

Objectivity in evaluating program impacts is the *sine qua non* of social science research. Social science researchers are, however, faced with several dilemmas when designing and conducting evaluations. Primary among these is their relationship with the policy-maker. The researcher is dependent upon the willingness of the policy-maker to grant him autonomy, since the policy-maker is the employer and the researcher the employee.

There may, unfortunately, be some grounds for the policy maker's fears that researchers will twist an evaluation study to mesh with their own research interests, but it is impossible to conceive of a reliable study in which the researcher does not have independence of judgment. It is one thing for the policy-maker to be closely involved with the program; it is another matter when political pressure perverts this involvement. It is possible for this sword to have two edges. On the one hand, policy-makers owe it to their constituents to see that the evaluation is conducted as designed, and they are thereby thrown into a "supervisory" role. On the other hand, the researcher may be torn between (1) fulfilling the obligations of the design itself, and (2) prolonging the program, and his job, with "satisfactory" findings. The meddling policy-maker and dishonest researcher are both obvious barriers to effective evaluation.

Another potentially disabling factor is the procedure by which many evaluation contracts are granted. Often the recipients of such contracts are individuals whose former involvement with the policy makers may not be neutral. It is a known fact that consulting firms are often staffed with individuals who were former employees of the government agency supervising the research.

Perhaps the trickiest political problem concerning program evaluation involves reporting the findings. Nothing is more perplexing to the policy-maker than to be presented with negative findings. If the policy-maker has significant political commitment to a particular program and the findings prove negative, the policy-maker may then assume the role of methodological critic, casting aspersions onto every phase of the evaluation procedure. Another possible result would be that the policy-maker might "table" the report. It may be, in fact, that the potential for negative results is a prime factor precluding the inception of an evaluation study.

CONCLUSION

These are but a few of the political and methodological factors that may act as impediments to conducting valid evaluations. Systematic evaluation is an absolute necessity if resources are to be wisely spent to produce fruitful results. Resolution of the political problems demands an honest, mutually respective relationship between policy-maker and evaluator. Surely, the needs of contemporary society will now forge this relationship. The methodological factors can be overcome with greater resources for program evaluation and with greater insight into the problems that the evaluator may face. As social scientists engage in greater numbers of truly interdisciplinary program evaluations (e.g., the impact of oil spills), the meshing of interests, skills, and efforts will serve toward rectifying the numerous flaws that currently exist in social-action public policy.

VI. PUBLIC INTEREST GROUPS AND OIL SPILLS

INTRODUCTION

The sixth session turned to two interest groups generally associated with oil pollution damages — environmentalists and coastal zone residents. Brock Evans, Director of the Washington, D.C., Office of the Sierra Club, stressed the fact that environmentalists see the human and physical systems as being inextricably intertwined. A discussion of social impacts, he said, implies a discussion of the physical impacts. But, Evans urged, we need further research on the ways in which social impact can be measured and described. He suggested that environmental organizations, which have had a successful history of documenting the physical damages and focusing public attention on oil pollution, can serve an active role in encouraging research and debate on the subject.

Mobilizing public response to the problem was also stressed by author Wesley Marx in his discussion of the cultural impacts of oil pollution and development on coastal zones. He described coastal communities as being the most urbanized areas on the planet and as being areas of potential social conflict. A confrontation between a traditional perspective of accepting the undesirable side effects of marine oil development as part of a necessary demand for meeting resource requirements and a newer perspective of seeking to reduce the demands was predicted. He also stated that coastal communities have incorporated social values and attitudes into their political processes and will continue to demand a greater voice in shaping their destinies with regard to coastal development.

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ROLE OF ENVIRONMENTAL ORGANIZATIONS IN CLARIFYING SOCIAL IMPACTS OF OIL SPILLS AND OIL POLLUTION

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There is little argument that the pollution from large and small spills of oil into the marine environment is one of the most widespread, pervasive forms of environmental damage that we face today.

Although there is still a great deal to learn, many of the damaging or toxic effects of oil pollution in marine environments are well known. What is less well known about oil spills is the impact on the affected human societies which are touched in one form or another by the chronic and increasing spread of oil pollution. While environmental organizations, as well as many environmentally-minded citizens, scientists, government officials and others, have been extremely active in the area of documenting damages to the physical environment resulting from oil spills, there has been little attention given to the other question. On the part of environmental organizations, this lack of attention to social impact can probably be explained in a philosophical context; that is, most environmentalists view the physical and human, or social environments, as being inextricably intertwined. Therefore, in speaking of one set of damages, the other is always implied.

Nevertheless, the entire subject deserves more careful scrutiny. Perhaps because environmentalists have been so successful in documenting, assessing, and focusing attention upon the specific physical damages from oil pollution, they may also have a positive and constructive role in focusing the debate on the social impacts of oil pollution in a manner that will encourage all parties to come up with constructive solutions to the problem.

THE NATURE AND OUTLOOK OF ENVIRONMENTAL ORGANIZATIONS

Some analysis of the structure, constituency, *modus operandi,* and outlook of environmental organizations is in order to better understand their approach and possible role. To begin with, there is no one great monolith called "environmental organizations." There are many different groups, all with different aims and constituencies. Basically, it is possible to divide environmental organizations into three distinct groupings from the national level down to the grass roots.

At the top, to use that term loosely, would be the large and familiar national organizations: Sierra Club, Wildlife Federation, Wilderness Society, and others. Each of these organizations draws from a national constituency, and each has somewhat different basic goals and orientation.

Second are the regional, or state-wide, organizations. Groups such as the Washington and Oregon Environmental Councils, the Alabama Conservancy, and the Federation of Western Outdoor Clubs are examples of this type. These groups, as their names imply, draw from regional constituencies, but still have a focus which transcends purely specific local issues. Then, at the third level, are the literally thousands of *ad hoc* groups, of varying permanency: the county environmental councils, the committees to stop freeways, to save parks, to clean up the air or to stop unwarranted power plants in certain localities. We are all familiar with these organizations; they are the real "grass roots" of the environmental movement.

But the strength of the environmental movement does not end here. To the three above categories, I would add a fourth — the public at large. Millions of people who are not direct members of any of these groups still share the beliefs and values of the movement as a whole and support its efforts. The public opinion polls show a 70-80 per cent support for stronger environmental laws; perhaps even more significant, a large majority are willing to pay more taxes to support environmental cleanup. Few other areas of American society today can boast such widespread public support, despite the talk about the alleged "environmental backlash." It is accurate and safe to say that there is a basic, common thread of philosophy which unifies these groups and causes them to work together. This philosophy holds to the fundamental

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belief that the planet earth is a system of delicate and interlocking life processes in careful balance; that these systems are fundamental to the support of all life, including the life of human societies; that the balances and interrelationships must not be too greatly strained or our life support systems, as well as everything that makes life worthwhile, will be damaged, perhaps beyond repair; and finally, that too often the use of modern technology by the human inhabitants of the earth has caused serious disruption or shattering of these balances and relationships. This common philosophy is not always articulated, but it is felt by environmentalists everywhere, whatever the issue or cause for which they are working at any given time. It is this philosophical outlook which makes it possible for environmentalist groups to work with each other on a constant and continuing basis.

There exists in this nation a rather informal organizational and informational network of environmental interest groups. The leaders of most groups know the leaders of other groups; and when there is a need for it, the leaders of the small groups appeal to the large groups for help. When there is a large national crisis, all groups chip in together, even if they are locally oriented. This is the strength, the heart and soul, of the environmental movement.

The method of operation for environmental groups, of course, varies according to their resources. Some have large, well-funded publication programs. Some can even afford at least some media advertising, although never in the quantity as that produced by even one medium-size business corporation. Some are able to find the resources to go to court if the issue is particularly significant; this is an avenue of redress that is increasingly turned to by some groups. Also, there is an increasing sophistication in the use of the media as well as an increasing effort to locate and make use of all the scientific and technical expertise that may be available in a given situation. Finally, the strength of environmental groups lies in its membership, 99.9 per cent of which is volunteer.

SOME BASIC PROBLEMS IN DEALING WITH THE IMPACT OF OIL SPILLS

Environmentalists have historically had difficulty in separating the threat of oil spills in the marine environment from the whole range of other oil industry activities which can result in some form of environmental degradation. Whether it is the construction of pipelines in the Arctic which requires the dredging up of whole river beds or the burning of the ultimate product in a crowded urban area through inefficient engines, which causes stiffling smog — all these activities and uses of oil are the cause for great concern. However, it is probably the threat of oil spills in marine environments which has been the prime factor in the organized political opposition to oil extraction and transportation activities in general. The disastrous impact of the *Torrey Canyon* and Santa Barbara oil spills were haunting memories that galvanized the bulk of environmentalist opposition to the Alaska Pipeline, for example. And the knowledge and memory of countless other spills, large and small, has served as the focal point for the stiffening and growing resistence to offshore oil drilling along the Gulf Coast and Georges Bank, to the establishment of super-ports off Delaware Bay, and to the construction of new refineries in environmentally sensitive areas.

When an oil spill does actually occur, however, there are many difficulties encountered by environmentalists who wish to assess the damages. The first difficulty is generally found in the attitude of the industry itself, whose agents or ships or machinery are the source of the spill.

The oil industry has enormous financial resources available to it, in a measure far above the resources available to any environmental organization, no matter how rich. With such vast sums of money available, the classic tendency of industry, in the case of major oil spills — if they cannot be ignored — is to flood the affected area, and sometimes the nation at large, with a barrage of public relations and media advertising designed to obscure the issue. This is followed up later in court where, again, the oil industry can bring its best resources to bear. Teams and batteries of the best legal talent string out an issue and muddy-up the question of fault and damages for years, until long after the public has forgotten. Thus, the problem of overcoming the barrage of public relations and hired legal talent is one of the first and most serious encountered by anyone wishing to document the effects of an oil spill.

The second problem sometimes encountered is the difficulty of obtaining good local expert testimony. Whole faculties in a given discipline relating to the spill can be retained with special grants and contracts to "study" the spill. In such an atmosphere, of course, even with the best of intentions, it is practically guaranteed that the oil companies' viewpoint will be supported, and any problems will be played down.

Such a situation is often serious for local environmentalists who would like to hear a scientific viewpoint other than that of the oil company in a given situation of potential damage. They do not have the resources to hire "consultants" and "experts" from famous universities around the country. Often, it is only their acquaintance with local scientists and faculty members which they can rely upon.

A third problem is political. The oil industries have enormous power at the national political level, and at some local political levels as well. There are tens-of-millions of dollars to be mounted in national advertising campaigns touting the "energy crisis" and the solutions to it — which always involve a relaxation of environmental laws and the opening up of more areas to be explored and drilled. Additional millions can be spent on the highest paid legal talent available, often hired away from the very federal agencies which were regulating them, to conduct further lobbying for relaxation of the rules and favorable treatment. Additional large sums are used to finance political campaigns at the executive and congressional levels for those who would be in any position to act favorably to the oil companies. This combination is so potent that the oil industry, to the best of my knowledge, has never been defeated in Congress on an issue of vital importance, with the possible exception of a small reduction in the oil depletion allowance. The vote on the Alaska Pipeline in Congress last month may have been the closest the oil industry has ever come to suffering a real defeat. In the crucial question of overriding the National Environmental Policy Act in the Senate, the vote was a 49 to 49 tie; in the House, a shift of a dozen votes could have defeated the oil companies and their supporters.

SOCIAL IMPACTS OF OIL SPILLS

I have pointed out earlier that, from the environmentalist's philosophical framework and outlook, the impact on the physical environment cannot logically be separated from the social impact on human societies. It is all part of the same web of life that binds us together; the impact on one sector, the marine life or beaches, for example, cannot be separated from the impact upon the human society which may live near it, or far away.

These social impacts take many different forms. If a person's favorite beach is ruined by sticky black globs of oil which will be there for several years, then that is an obvious degradation of a person's quality of life in that area. If a prime fishery is destroyed, it may mean the destruction of someone's livelihood. The sight of thousands of dying birds covered with oil slicks has sickened many people for years after the event. Passage through the oceans themselves has become more unpleasant as people observe ever larger masses of drifting oil slicks. These are all negative social impacts of oil spills.

We can recognize the impacts of all activities of the oil industry, but we must arrive at a mechanism for properly assessing them so that we can, hopefully, control them, or, at least, fix meaningful liability for damages as they occur. We need to reform the political system to enable citizens' groups and others interested in the public welfare to somehow match, on equal terms, the overwhelming political and economic power of the oil industry.

Hopefully, environmental groups, with their proven record of expertise and ability in marshalling public opinion and in focusing debate on specific issues, will have a role in bringing to the attention of the nation the real social impacts and costs of oil pollution.

THE COASTAL ZONE AND OIL SPILLS: CULTURAL SPLITS

WESLEY MARX
Author,
"Oilspill," "The Frail Ocean"

The Environmental Impact Statement (EIS) by the Interior Department on the Trans-Alaskan Pipeline observes that the pipeline may open up new avenues to material wealth for Alaskan citizens. The EIS notes that this opportunity could disrupt an existing culture, with its traditional values and community structure. A potential spill on one watershed might disrupt the food supply of nearly 5,000 residents. An agency not always represented in EIS's, the Department of Health, Education and Welfare, recommended that such possible impacts on social structure, family life, and public welfare policies be more thoroughly considered. The impacted group, as you may surmise, is Eskimo. The cultural switch would be from a subsistence to an industrial economy. The potential spill impact was related to a salmon run serving about 50 Eskimo villages. The EIS notes that such a spill might compel those Eskimos who preferred the existing culture to join the new culture.

We do not like to submit ourselves to the cultural analysis we tender — however slight — to Eskimos and American Indians. Yet economic and environmental factors obviously fail to fully explain the social impact of oil in the marine environment. There are many other significant factors — historical, political, legal, social. Combined, these factors are sometimes regarded as emotion, sometimes as power politics, and sometimes as culture. Given only the size of the spill and conflicting damage surveys on marine resources and coastal property, no one could have predicted the social and political impact of the Santa Barbara spill. Yet clear hints of this impact existed, not in ecological base lines, but in community history. On his second visit to Santa Barbara in 1859, Richard Henry Dana, author of *Two Years Before the Mast*, found the natural attractions of this "dreamy town" still intact except for one offshore incongruity, "an unromantic, sail-less, spar-less, engine-driven hulk!" At the turn of the century, another mechanistic intrusion — offshore oil development — triggered community debate on whether Santa Barbara's economy and way of life should be tied to oil or to tourism and natural amenities. Just as significantly, state and local officials debated political control of offshore development. Prior to the 1969 spill, a state offshore sanctury closed to oil drilling was established off Santa Barbara City. At the same time, a coastal refinery proposal opposed by Santa Barbara County was established on the county border by permission of a neighboring county. Thus, Santa Barbara had a long history of concern over oil, even without a major spill. There were certainly ample storm warnings that a major spill could have major repercussions. It is interesting to speculate if a prediction of the regional or national impact of the Santa Barbara spill would have encouraged different or more cautious development strategies by the oil industry or the federal government.

Oil in the marine environment — or its specter — is caught between conflicting perspectives on the destiny of the coastal zone and who controls this destiny. One perspective, particularly popular at the federal level and in industrial circles, tends to regard the coastal zone as an undeveloped frontier, a frontier with tremendous potential to sustain America's affluent lifestyle, to provide substantial federal royalties, and to reverse foreign balance of payments. Amid these bonanza-like visions, the broad impact of such development — even the need to assess it — can be easily overlooked.

Yet, for coastal states from Maine to Washington, the coastal zone is an urban problem, plagued by pollution, erosion, transportation congestion, onshore and offshore and suburban sprawl. Coastal states thus grapple with the consequences of accommodating unlimited demands on a limited resource: the coastal environment. To complicate this, many demands require a high-quality environment: recreation, leisure, sightseeing, a sense of exhilaration or relaxation. While hard to quantify, these demands are deeply felt and often shape attitudes towards economic or ecological issues. For many communities, the natural environment is the basis of historical and cultural existence. Many coastal communities began in the 19th century as religion-oriented vacation retreats to restore the spirit and faith of harried urban dwellers. In the 20th century, passive beach recreation gave way to active beach recreation, from strolling to

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surfing, from sermons to sex-in-the-sun airline ads. There are now large coastal communities — virtual downtowns of leisure — where the fastest-growing labor segment, the labor-intensive service industry, is tied closely to the quality of natural values. The Eskimo is not necessarily alone in his orientation to — and dependence on — natural values.

Thus, coastal states are being compelled to integrate social values and attitudes, however unquantifiable, into the political process now. The mechanism is at the level of a city council, or planning commission, or regional commission. The atmosphere is hardly scientific and often quite contentious. Votes may occur at one o'clock in the morning on public beach access, hi-rise limits, dredge-and-fill permits, or sewer hook-ups. However, this process is *public* and does enable citizens to influence impacts on their natural and social environment.

Coastal states are thus engaged in a most challenging political task: attempting to sustain or restore a high-quality environment in the most urbanized area on the planet, the coastal zone. Coastal states are under pressure not only from voters but from federal agencies such as the EPA, the National Marine Fisheries Service, the Bureau of Sport Fisheries and Wildlife, and the Bureau of Outdoor Recreation. In many cases, these agencies urge coastal states to forego short-term economic benefits such as estuarine reclamation for more social and environmentally sound long-term benefits such as estuarine preservation.

Many coastal states find it impossible to sustain a high-quality environment without changing the nature of demands impacting this environment. After so many years of acrimony over offshore development and coastal power plant siting, California recently adopted a mandatory housing insulation program to reduce energy demands. This year the California legislature passed a bill to establish an extensive energy conservation program and a research program into pollution-low energy sources. (The governor vetoed this bill, which will be re-introduced in the 1974 legislative session.)

Thus, while one traditional perspective would accept side-effects from marine oil development as an undesirable but necessary part of meeting resource demands, another emerging perspective seeks to reduce or prevent such side-effects by reducing or changing demands. Cultural outlooks tend to reverse goals in each perspective.

Therefore, it is no wonder that responses to oil in the marine environment can be so conditioned by cultural outlooks. Responses even differ between coastal states. Potential damage from a major spill off Louisiana is as great or greater than one in the Santa Barbara Channel. Yet concern is not as great, even among the Cajuns of the coastal bayous whose historical and cultural existence is tied to the marine fertility of the coastal marshes. It so happens that many Cajuns sustain their prized but economically marginal existence as independent shrimpers by working part-time on marine oil rigs.

In Florida, the specter of oil in the marine environment becomes a relatively new stress that threatens efforts to protect the coastal amenities that originally attracted residents. In Maine, a spill challenges the ability of people to control the circumstances of their existence. In a Congressional hearing, Richard Dodge testified that a spill in Casco Bay severely damaged rockweed that he and his father had harvested for 25 years. The rockweed is used for packing lobsters and in clam bakes. Noted Dodge, "This July spill has placed me in the dubious position of having to purchase petroleum products to go further and further away from petroleum-contaminated seaweed in search of a clean marketable product."

In this unresolved situation, oil spills, with their high visibility and their knack for indiscriminately crossing political boundaries and perspectives, will be a continuing catalyst for policy reform. Coastal states and their citizens want to be part of the process that determines policies on the Continental Shelf, regardless of political boundaries. Just as they are being asked to do, coastal states on occasion will be asking the federal government to forego immediate short-term economic benefits for more social and environmentally sound long-term benefits.

Assessment of social damage in oil spills seems to me a critical step in resolving some of these cultural conflicts, particularly in the following areas:

1) Establish a process by which all parties that may be impacted by a spill can be identified and can participate in decision making on assessment criteria, prior to an actual spill.

2) Develop alternative compensation schemes; i.e., can funds to cleanse oiled birds be better used to acquire habitat to insure coastal bird survival?

3) Create assessment criteria that recognizes a coastal region's economic and social reliance on renewable marine resources and on consumptive uses.

4) Clarify spill liability; i.e., to what extent may the federal government, as administrator of Outer Continental Shelf development, be liable for spills that damage coastal states?

5) Incorporate more damage assessment data into environmental impact statements on marine oil development to more effectively reflect the broad impact of such development.

6) Integrate data on biological damage into joint federal-state programs to better manage and protect living marine resources, including basic life support systems. This vital area of coastal management is dangerously overshadowed by the drive to exploit nonrenewable marine resources.

7) Integrate assessment research into a hazardous mitigation element for coastal management.

It is time that we view the impact of oil in the marine environment on us in the same broad perspective that we tendered — however slight — to the Eskimo.

VII. DIRECTIONS AND PRIORITIES

INTRODUCTION

The problem of studying the impact of oil development on coastal communities was only one of several concerns discussed during the question and answer sessions following each presentation. These problems occasioned heated debate and spin-off discussions. Questions arose concerning assessment techniques in botn the natural and social sciences. Joseph Porricelli's statement that the technology did exist to minimize the risks involved in oil transportation was enlarged upon by Hang-Sheng Cheng who argued that the economics of segregated ballasting make it an impractical technique. This debate continued in an informal discussion group with detailed presentation of the view in question.

Stephen Dorrler's comment that oil spill cleanup costs range from $.50 to $14 a gallon also occasioned discussion. The participants questioned the broad price range for standardized cleanup costs and asked if these figures indicated deficiencies in current cleanup technology. The efficacy of current assessment operations was also questioned. Royal Nadeau had described EPA's attempts to assess the damages of an oil spill, but admitted that the base line studies of pre-spill conditions are difficult to find and that natural scientists have little knowledge of the long-range effects of oil on organisms and ecosystems.

Deficiencies also appeared to exist in the social science areas of assessment. The legal, economic, and social assessment frameworks also generated debate and discussion. While it was agreed that systems analysis could provide a useful methodology, debate on the difficulties of assigning numerical values to non-economic considerations was vigorous. Debate also centered on current efforts to arrive at economic estimates of damages.

However, other methods of evaluating impacts also received careful scrutiny. In both the corporate response session and the public interest groups' session, the participants raised questions on how to measure the public effects of an oil spill and how to use this measurement to arrive at a solution to the problem. Both Ron DeNoville and L.P. Haxby had discussed immediate, tangible measures that are usually taken when an oil spill occurs, but the question of a long-range solution to the problem remained unanswered. Norman Sanders suggested that participants reject the philosophy of "learning to live with oil" and asked the group to consider alternate energy sources as an ultimate solution. He presented his views in an informal discussion. (Sanders, along with Hang-Sheng Cheng and Thomas Busha, of IMCO, prepared papers which illustrate the topics considered during informal discussions. These papers appear in Appendix A.)

The subject of how, ultimately, to minimize or eliminate the effects of oil spills on society, while discussed throughout the symposium, was viewed as secondary to the group's major consideration. Determining the actual social impacts of oil spills was seen as the paramount, immediate concern. While it was agreed that social response could be studied by examining the existing legislation, by working out economic analyses, and by modeling cause and effect relationships through systems analysis, it was also agreed that the social sciences needed to provide significant input. Both Brock Evans and Wesley Marx had illustrated that public concern does exist and can be mobilized in support of research programs to aid in decision making. The participants asked this question repeatedly: "If this is so, how can we measure and define it?" Frank Scioli and Thomas Cook had suggested that, at present, we cannot answer the question but that an answer must be found.

Therefore, the final session was concerned with the future directions of the assessment of social impacts: specifically, what methodologies and allocation of funds would most efficiently attain the goals for damage assessment that had been formulated during the first task team assignment? The session began with remarks from political scientist Bert Swanson on ways for operationalizing the participants' enthusiasm and expertise.

He described work currently being done in the area of community studies and suggested that one immediate outcome of the symposium could be a voluntary, prototype emergency response team which could begin to describe the social impacts. This team, composed of problem solvers with proven success records in relating rapidly to persons and events, could be called on for on-sight investigation of a spill incident and could provide rapid, broad-scope analysis. He suggested that such a team could begin in Florida with the various residents of the state who were participating in the symposium. Swanson also suggested that although official governmental sanction for such a team would be desirable, its initial operations should not be impeded by bureaucratic considerations. His approach implied that if a call for immediate action were to be given, response could be made despite the academic uncertainties surrounding the term "social impact."

CONSIDERATIONS ON THE GOVERNMENTAL RESPONSES TO ENVIRONMENTAL CRISIS OR DISASTER

BERT SWANSON
Professor, Department of Political Science,
University of Florida

As the last speaker for this symposium, I would like to provide a sense of what we seem to be learning. In addition, I would like to furnish some more variables for your consideration and suggest some follow-up activities. First, when we discuss "Petroleum Out of Place" ("POOP"), we mean oil spillage from a variety of sources. In addition to tanker accidents — by sea and land — oil enters the environment through pipeline leaks, industrial wastes, and onshore accidents. We should also consider the setting of a spill — harbors and coastline spills are most sensitive areas. Similarly, we should be concerned about the magnitude and frequency of spills. Thus, the scope and intensity of oil spills is an extremely important consideration since we may be faced with a disaster, which occasions an immediate, unfavorable change to our lives, or a crisis, which may be less severe but still have significant consequences. While the former generally calls for an immediate response, the latter may only be a turning point in which no immediate or critical response is called for. Rather, it involves a continuous flow of events which can show us whether or not we should modify our behavior and whether or not we have time to change our course of action — whether or not we can anticipate the consequences accurately and comprehend enough to plan an appropriate response.

At this point in time, we have the opportunity to examine the problem of oil spills and our societal response to them. To this end, we should determine just what policy variations we should seek and what rearrangements we should make in the policy-making system itself. My concern and focus is on the willingness, ability, and effort of our governmental systems to respond to either crises or disasters when they occur. Within our federal system, formal governmental responsibility is differentially shared by state and local governments. In conjunction with formal authority, there is the informal exercise of influence, often from the private sectors, that is significant in determining public policy outputs. When discussing both the formal and informal means of controlling or influencing public policy, we should perhaps also consider the international aspects of the problem. It has been stated that if there is any world government in existence today, it is probably to be found in the oil industry. It is not totally clear how the U.S. government and the international oil industry interface, other than in a producer-consumer or regulator relationship. But if there is an international arrangement, it would affect all other decision-making systems within our country and should be better understood.

Perhaps more important than the formal linkage of responsible governments is the informal network of information that occurs outside these systems. This network attempts to control, dominate, influence and shape the policy of the authoritative system, and it is extremely important to analyze this relationship. For example, Wesley Marx indicated that there is a cultural variation in the coastal zones affected by oil development. In addition, most studies have found that there is an unequal distribution of political power operating in most policy making. The "New Federalism," for example, is an effort to shift the focus of authority and influence from the national to state and local government who are expected to play a greater role in shaping procedures and policy outcomes.

This informal network of information and influence is one of the least studied and least mentioned set of variables at this conference. In my work with many public officials at the entry level of government, the question they invariably ask when presented with a policy analysis is, "I know what the answer is, just tell me how I got there." What they are asking for is not an empirical investigation which particularly clarifies their goals, but a justification of their goals. Most decision-makers I have worked with would be only partially persuaded by all the rational sets of variables we have arrayed here. They must deal, at all times, with the realities of getting re-elected or of keeping their appointed positions.

Both formal authority and informal influence factors are important in understanding policies concerning oil spills. Let me delineate situations to which the governmental response is likely to vary on oil spills. The first period is a period of "normalcy" where little stress is placed on the system to respond to environmental concerns. The government and the oil industry are the two primary actors, with an implicit understanding that government is acting on behalf of the consumer. It is a period in which there is little distinction between the producer and government even though the latter is expected to regulate the former.

The second phase is one of environmental concern. A new set of characters has entered the scene. The environmentalists have not only expressed their concern for what is happening to the quality of the air, water, and land, but have sensitized the public to share their concern. They have often characterized the situation as a disaster or crisis. The governmental response at first was an *ad hoc* one searching for

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short-range solutions to deal with immediate problems of reducing the impact and restoring the damage. It was at this time, however, that another actor was added by the federal government, the Environmental Protection Agency (EPA). This agency is, in a sense, "the new kid on the block." It has considerable political support and the legislative authorization to comprehensively and continually protect the environment. Whether this new agency will survive or be shaped to serve producer interests is, I think, a fair question to ask. It may be co-opted into the vast federal bureaucracy and lose its mission to serve its new constituency — the environmentalists. Thus, while the oil industry and the normal regulatory machinery of government are still the two primary actors, EPA could also become an important actor on behalf of the consumer.

EPA, however, is currently involved in a third phase in an effort to identify, monitor, and modify some of their longer-range concerns. They must make continuous efforts to reduce the probability of reoccurrences of oil spills. But the greatest efforts should be on modifying a vast variety of practices, assigning responsibility, and allocating costs thereto. They have little time to put their responsive program together, since a fourth phase is already upon us. We now hear the claims of an "energy crisis" which will definitely shape the kinds of response both EPA and the public will be able to make. With the emergence of the "energy crisis" we should expect a challenge to the accomplishments and environmental standards that have been adopted in recent years. Therefore, I believe it important to understand the different policy responses to each perceived phase of stress and sense of crisis. Certainly EPA's constituency needs to develop firm roots within the system if its mission is to be accomplished.

To develop these roots in a short time is a difficult task. There is obvious disappointment in the social science knowledge base to establish any standards of measurement in assessing the social impact of oil spills. The problem, simply, is that there are few sophisticated measurement techniques already available. Nor have the social sciences been able to provide a very predictive science. However, in the field of community studies, we have begun to make a systematic study of the variables influencing community decision making. We know, for example, that the larger the community in population, the less controlled the community conflict is. The larger the size of the city, the greater number of events become issues — the greater the number of decisions — the greater the role of technical expertise. We also know that the outputs from any decision making reflect the values and interests of the dominant, influential sectors of the community. But much of this social science knowledge is not immediately available to address itself to the kinds of problems being presented at this symposium.

Therefore, I'd like to offer these recommendations concerning where we go from here. My first suggestion is for the establishment of an ongoing, prototype response team. This team would be available to investigate the occurrences and, using a series of discussions, to evaluate what had actually happened to the affected community. Obviously, different perspectives would be needed, but I do not recommend a sharp focus on a multidisciplinary approach. It has been my experience that people in various disciplines devote more time to working together breaking down communication barriers than to tackling the problem. Rather, I suggest that we organize a team of experienced problem solvers who have the ability to respond quickly to a given situation. They would have to make field inspections and then be able to discuss the various dimensions of the problems they have just observed. As to who would sponsor such a team, I suggest that it be voluntary at the onset. Although I favor a governmental sponsorship since it is important to use the basis of authority to bring about effective action in this field, it would simplify matters to begin without any official base. I also believe that the focus of the response team should be "macro" rather than "micro"; that is, it should look beyond the affected individuals to the social systems involved — the families, organizations, communities. It should also attempt a comparative analysis, relating the impacts on one area to impacts on another.

Although I do not want to make too sharp a distinction between this action research and other forms of investigation, I do think that we could simultaneously undertake a carefully thought-out research agenda. In fact, we could begin to delineate the parameters of the problem by working on the flow chart provided in the pre-conference readings. Our primary task would be to identify priorities and determine the critical areas for research. There should be a mix of priorities; for example, we should study the food-web as well as the organizational responses. Perhaps the biggest problem we face in this area is that we really do not know what the social system of response is and we have, as yet, no organized method for public opinion input.

This leads me to a final, very generalized recommendation. When analyzing the social impact of oil spills, we cannot ignore the concept of the "partnership" arrangement in government. In the area of urban affairs, the metropolis is no longer comprehensible or ameliorative to a single unit of government or to a single display of community influentials. By and large, what needs to be done in urban America gets done by an overlapping system of legal jurisdiction of municipalities, counties, state, regional and national governmental units. Problems affecting a large metropolitan complex extend beyond its reach. Therefore, we must assume that extensions of governments and their various authoritative sanctions operate simultaneously and in partnership in a metropolis. Is there throughout the oil-environmental system a common interest? I think that there is, and I think that the national interest requires a response to it. The question is not whether or not we are going to see governmental responses to the problem of oil spills. The question is whether or not we have the organizational capability to assess the social or political response to the social impacts of "POOP."

TASK TEAM SESSION #2

The symposium concluded with a second problem for the task teams to solve. Since the participants had, by Friday morning, heard all the various areas of assessment that might be included within the term "social impact," they were now in a position to offer some specific program directives. In fact, the second task asked them to develop a program to assess the social impacts of oil spills. This program was to include goals, methodologies, organizational arrangements and budget allocations; in essence, the second assignment called upon the participants to evaluate the approaches offered during the symposium in order to provide for equitable, comprehensive damage assessment.

The second task is reprinted below. Edited responses of task team representatives are presented in reverse order, as they were delivered at the symposium.

TASK II

The Issue

The issue before the task team is how to best allocate limited resources (time, money, people) to improve our capabilities to assess social and ecological impacts of oil spills. For the purposes of discussion, *assume* your task team has been commissioned by a federal government to develop a *program* to assess social impacts of oil spills. The system should be designed to meet the goals your task team established in Task I or a revised set of goals.

Assume further that your team has the responsibility to allocate $10 million in calendar year 1974. Your team should:

(i) Delineate the goals for your program (reconsider the Task I goals — accept as is or change).

(ii) What approach should your program use (case studies, data gathering and research, active intervention in policy decisions, etc.)?

(iii) Specify what organizational arrangement you feel would be the most appropriate (governmental agency, independent agency, university affiliation, some combination).

(iv) What type of staff or team would be needed — number of people and their expertise?

(v) What activities would the staff undertake and what would be the budget allocation ($10 million) for each activity?

TASK TEAM 7

Charles Bates, Science Advisor to the Commandant, U.S. Coast Guard

Before discussing our recommendations, we would like to stress the fact that an ongoing program of damage assessment must address itself to problems of prevention and to the chronic small spills that contribute to overall oil pollution of the marine environment. The conference has emphasized the large, catastrophic ocean spill, but we should not forget that there are other aspects to the problem. To address an assessment program to the problem in its entirety, we need to include case studies of typical coastal communities before and after a spill. Typical target areas for base line studies would be:

1) changing life styles in affected communities
2) one-shot types of spill impacts
3) chronic spill impacts
4) cost-benefit analysis for: tangibles, intangibles (short- and long-term) and retribution
5) oil spill impact vs. other types of pollution impacts
6) international practices of handling pollution impacts
7) history and trends in protection and use of natural environment.

Such a program could be instituted under the National Contingency Plan, Federal Register Vol 3P, 155-2. It would follow the Plan's directive to take measures to minimize damages from spills. The program's immediate response team could consist of personnel trained in ship salvage and removal technology (using members of the U.S. Coast Guard) and an environmental response team of biologists, chemists, engineers, meteorologists, and oceanographers (drawing from the EPA). The lead organization should draw from a mixed spectrum of all governmental, industrial, university and "think tank" skills and should include:

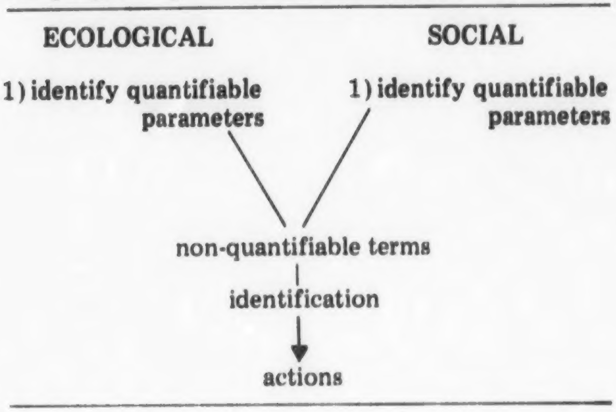
1) hard scientists (engineers, "quantifiers")
2) traditional cost-benefit analysts
3) "soft" scientists (assessors of human reactions and values, such as cultural anthropologists)
4) ecologists (concerned with the whole life system)
5) senior political statesmen.

Finally, the question of how much money would be needed to determine the entire spectrum of necessary knowledge, including the sociological impacts, is difficult to answer. We would begin to estimate the costs for areas in which analogous kinds of research have been done, but assessing the *social* impact of oil spills is such uncharted territory that we would need to do a prototype study of some similar area in which data does exist in order to arrive at an estimate of the allocation of costs.

TASK TEAM 6

Niels West, Assistant Professor, Dept. of Geology and Geography, Hunter College

We decided that Task II should not be limited to the assessment of social impacts, but should have as one of its goals the development of methodologies within the ecological sciences for impact assessment. The program's goals can be charted in this fashion:


ECOLOGICAL
SOCIAL
1) identify quantifiable parameters
1) identify quantifiable parameters
non-quantifiable terms
identification
actions

We suggest that the organizational structure begin with the federal government. An advisory board could be set up which could pool the resources of universities, research organizations, and governmental agencies. The researchers should adopt a *pragmatic approach to establish a relative hierarchy of the social values under investigation;* for example, the economic values of the community, its environmental awareness, the existing local regulatory structure. Obviously, these researchers would need some federal direction, but the basic staff should consist of local talent. We see the budget being divided as follows:

spill investigation (20%)	overhead (20%)
base line data (40%)	design (20%)

We see the first year of this program as a year of research and evaluation, and the budgeting chart we have presented should be overlaid with a fifty-fifty emphasis on these two areas. In conclusion, the program we've briefly outlined would not include any political activities. It would be a program of data gathering and research that would attempt to develop methodologies for damage assessment.

TASK TEAM 5

Brock Evans, Director, Sierra Club, Washington, D.C.

Any program organized to assess the impacts of oil spills should move beyond means of measurement to means for the minimization of impacts. Our group felt that, keeping this overall objective in mind, we could answer the five parts of our task readily. First, we need a *continuing* program for assessing the social impacts of oil spills. Second, we need a mix of approaches to the problem and we could begin by organizing a task force to formulate a strategy and to determine the present state of the art. Third, the lead agency could be any competent federal group concerned with ecological problems such as the National Academy of Sciences or the Council on Environmental Quality. Fourth, we urge a *small* full-time staff with an outside support staff, say ten to fifteen people, composed of persons having various perspectives on the problem; i.e., mayors or politicians from the areas affected by oil spills, citizens' group representatives, etc. Our group decided that we really had no way of answering the last part of the assignment, the allocation of funds, other than to say that, at first, only small amounts, honoraria, should be awarded. To conclude, we would like to stress two important considerations. First, when a spill occurs, we need to know what the *immediate* social response is — what fears do the people have? Second, we need to find ways of measuring whatever it is we mean by "social impact."

TASK TEAM 4

Alan Soltow, Chairman, Dept. of Economics, University of Oklahoma; Norman Sanders, Assistant Professor of Geology, University of California at Santa Barbara

In delineating goals for our proposed program, our task team agreed that there was no way to divorce the ecological from the social impacts. Since there is a general lack of data in impact assessment, we suggest doing base line studies on a dozen or so areas of high oil spill probability. We also suggest that a standardization of measurement for economic assessment be formulated. Specifically, we suggest that base line studies to establish the relative hierarchy of social values be conducted. These studies, which would include the monitoring of conditions before and after a spill, should focus on:

1) economics

2) ecological impacts

3) health hazards
   a) physical
   b) mental

4) political structure and local regulation

5) basic community values.

We see a proposed environmental assessment board lodged in a governmental institution, since federal funds would be used. But the success of this board's assessment teams would depend on local acceptance, and it would rely heavily on the capabilities of local assessment teams. These teams should consist of generalists, not specialists. In conclusion the assessment program should show no bias toward or away from academicians, or, in fact, polluters.

TASK TEAM 3

Philip Sorenson, Associate Professor and Director of Graduate Studies, Dept. of Economics, Florida State University

We recommend long-run funding commitments for base line studies on ecological systems in areas of high risk, including open seas and ground and inland surface waters. In particular, we recommend continuing base line studies of *chronic* oil pollution sources. Also, we recommend funding for development of a comprehensive economic inventory of direct and indirect costs in acute and chronic oil spillage. The purpose of these studies should be the development of a consistent methodology for economic damage assessment, including determination of included and non-included cost categories. General sociological and social-psychological investigations, while important, we believe cannot at this time be regarded in an operational framework. Since we assume that this task is outlining a first-year funding program, we suggest that the budgets should be divided 75 per cent for base line studies, 25 per cent for economic inventories.

In answer to the second part of the assignment, we recommend direct data gathering and research on ecological systems. We advocate no active intervention in policy decisions. Literature studies, evaluation of previous research, case studies, development of methodological constructs, conferences and evaluations, and attempts at standardization of measurement should be implemented for economic damage assessment.

For the third part of our assignment, we recommend that an independent governmental commission on oil spill evaluation should be established to oversee funding allocation, to supervise the research operations, and to evaluate all relevant activities. This commission should be composed of university researchers, federal officials, and industrial and citizens' groups representatives. The support staff could be added as required, but most of the work should be done by outside researchers. Finally, we suggest that this funding program, based on our first year estimate of 75 per cent to ecological research, 25 per cent to economic damage assessment consist of the following.

	Ecological (75%)	Economic (25%)
Program Planning and Project Evaluation	10%	10%
Field Research	20%	0%
Pure Research (including theoretical modeling)	25%	10%
Administration	20%	5%

TASK TEAM 2

Russell Dynes, Co-Director, Disaster Research Center and Professor of Sociology, The Ohio State University

Since the teams which have come before us have spelled out their recommendations in such detail, we will take this opportunity to provide some general observations rather than address the individual points of the task. When an oil spill occurs, it is obvious that something has happened which can be perceived and observed, that is amenable to research. We know that we can gather information on its impacts. The question is, then, what is the best method for collection? We suggest that the development of base line data be determined not only by the hard facts, but also by the perceptional factors and variables at work. We need data on the physical and social impacts, but we also need to investigate the comparative social impacts. Our team saw two other important general precepts for any assessment program. The results of its investigations should be widely circulated so that all researchers could make use of its findings. Finally, the assessment program should include, as one of its goals, the evaluation of the legislative impacts on a community. It should examine how existing or alternate legislation would affect a spill's impact on a community. It should, in short, view the full spectrum of impacts from a spill.

TASK TEAM 1

Thomas Post, Board of Port Wardens and Private Law Practice, Miami, Florida

To date, government, industry, and the institutions have been most concerned with the technical and legal aspects of oil discharges. Studies in these areas by industry, the scientific community and the environmentally concerned segment of our society have been directed toward discovering methods of deterring and preventing discharges. So far, great strides have been made in this area. But if we broaden the scope of our investigation to include wide-ranging social impacts, we feel it would be desirable to maintain in social impact studies the goal of discovering

Pollution of the Inter-governmental Maritime Consultative Organization (IMCO), scheduled to take place in October 1973. It further requires the Coast Guard to put the U.S. regulations unilaterally into effect no later than January 1, 1976, in case the IMCO Conference fails to reach agreement.

(2) International Aspect

The U.S. proposal has now been incorporated into the Final Draft of an *International Convention for the Prevention of Pollution from Ships*, 1973[4], for consideration at the October 1973 IMCO Conference.

Specifically, Regulation 9 of Annex I: "Regulations for the Prevention of Pollution by Oil" of the Draft IMCO Convention limits discharge of oily water as to (a) area: more than 50 nautical miles offshore, (b) amount: less than 1/15,000 of the cargo[5], and (c) rate of discharge: less than 60 litres per nautical mile.

Regulation 11 specifies the operating methods "appropriate" for compliance with the discharge standard stated in Regulation 9. The three methods specified are (a) segregated ballasting, (b) "load on top," and (c) in-port disposal to shore-reception facilities.

From the viewpoint of this paper, the most controversial provision of the Draft Convention is Paragraph (2) of Regulation 11 which would require all new tankers of 150,000 tons and above, contracted on or after January 1, 1978, or delivered on or after January 1, 1981, to be "designed, constructed and equipped" for segregated ballasting in accordance with specifications provided in Regulation 13. This requirement is consistent with the U.S. Coast Guard's proposal to permit existing tankers and small new tankers to practice load-on-top, but *requires* large new tankers to be constructed for segregated ballasting.

It is this last-mentioned requirement that constitutes the central issue of this paper. In the following, an attempt will be made first, to estimate the incremental benefits and then, the incremental costs of the policy.

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5) (The percentage reduction in world oil pollution in 1980 by compulsory segregated ballasting can be derived from (3) and (4).) The ratio may be considered as measuring the **incremental technical effectiveness** of that policy
6) Estimated economic and non-economic costs to the U.S. and to the world in 1980 of ocean pollution from all sources
7) **Estimated incremental economic and non-economic benefits** of compulsory segregated ballasting can then be derived by applying the ratio obtained in (5) to the estimates obtained in (6).

In practice, however, the underlying data for Step (6) above are particularly lacking. The only available estimate pertains to the economic cost to the United States of ocean pollution in 1971. In the analysis to be presented below, that estimate has been projected to 1980 and used in Step (7).

Note also that the underlying data refer to various types of segregated ballasting. For simplicity, only two types, the single-skin[6] and double-bottom methods, will be selected for analysis. They should, nonetheless, provide a sufficient idea of the differential impacts of using different types of segregated ballasting.

The derivation of estimates is presented step by step as follows.

(1) Number of Large New Tankers to be Affected

It is reported that at the beginning of 1973 a total of 533 tankers were under construction with an aggregate capacity of 88.2 million deadweight tons (DWT). Of this total, 276 are said to be more than 175,000 DWT each.[7] It may not be too far wrong, therefore, to guess that there are about 300 tankers of 150,000 tons or above now under construction.[8] That number — 300 tankers — however, is not what we need, for, as noted above, neither the Draft IMCO Convention nor the proposed U.S. Coast Guard rules-making requires segregated ballasting on tankers now under construction. The number is to be used merely as a stepping stone in further calculations.

In another study, it is estimated that, in order to satisfy 90 per cent of the projected tanker demand in 1980, it will be necessary to construct 8,100 tankers of T-2 equivalents in addition to what are already contracted for construction.[9] Given the capacity of a T-2 equivalent as 16,600 DWT, this implies a projected additional tanker demand of 134.5 million DWT. If we assume that about the same proportion of this demand will be met by tankers in the "150,000 DWT or above" class as that which the 300 super-tankers bear to the aggregate capacity of 88.2 million DWT now under construction, we may estimate that about 450 additional super-tankers will be contracted for 1980 or earlier delivery.

Given the rising trend towards the construction of larger tankers, the estimate might be thought to need

APPENDIX A:

INCREMENTAL BENEFITS AND COSTS OF COMPULSORY SEGREGATED BALLASTING REDUCING OIL POLLUTION OF THE SEA

BY

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Research Staff,
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I. INTRODUCTION

This paper presents a cost-benefit analysis of the existing U.S. tanker-design policy that would require all large new tankers constructed after a date no later than January 1976, to be equipped for segregated ballasting. At U.S. initiation, a similar requirement for tankers engaged in international voyages has also been included in the Draft International Convention for consideration at the October 1973 meeting of the Intergovernmental Maritime Consultative Organization (IMCO) in London. As the policy should have considerable impact on the future of U.S. and international tanker construction and operation, a rigorous analysis of the costs and benefits involved is very much needed.

The study finds that the incremental benefits derived from requiring segregated ballasting over and above the existing base-ship designs is exceedingly small in comparison with the incremental costs involved. A serious question is thus raised on whether the policy of compulsory segregated ballasting is warranted.

Section II will outline the principal features of the present U.S. policy and of the Draft IMCO Convention on segregated ballasting. Section III will examine the incremental benefits and Section IV, the incremental costs of that policy.

It is recognized at the outset that both the benefit and cost estimates are very rough since the underlying data base is weak and fragmentary. In their defense, however, it should be pointed out that the data appears to be the best available. Moreover, the general order of magnitudes of the estimates is such that the *qualitative* conclusion of the study is not likely to be altered, even if one may have reservations over the exact quantitative estimates presented herein.

Intellectually, what is more important is neither the precision of the estimates nor even the policy conclusion, but rather the general methodological approach presented in this study. A rigorous benefit-cost study is notoriously difficult, and, hence, rare on the subject of government policies for abating ocean pollution. This paper is intended as a contribution for stimulating further efforts in that direction.

II. PRESENT U.S. POLICY AND THE DRAFT IMCO CONVENTION

The present U.S. policy on segregated ballasting contains a domestic aspect and an international aspect. The former is embodied in the U.S. Coast Guard's proposed regulations following upon the Ports and Waterways Safety Act of 1972. The latter consists of U.S. initiation and support of the provisions in the Draft IMCO Convention on segregated ballasting.

(1) Domestic Aspect

Title II of the Ports and Waterways Safety Act of 1972 *requires* the U.S. Coast Guard to establish rules and regulations setting forth standards of vessel design for the purpose of protecting the marine environment. The legislative history of Title II leaves no doubt that the Congress was particularly interested in exploring the possibility of requiring segregated ballasting, specifically in the form of double-bottoms[1] — for tankers and oil barges operating in U.S. waters.

In January 1973, the Coast Guard issued an advance notice of proposed rules-making[2]. It would require that all new tankers above a certain unspecified size whose construction is to begin after January 1, 1974, or which will be delivered after January 1, 1976, be equipped with segregated ballasting of not less than 45 per cent of the ship's full-load displacement. It further suggested that the segregated-ballast capacity "would be achieved in part" by fitting a double bottom of no less than one-fifteenth of the ship's beam. Existing tankers and small new tankers would be permitted to practice retention of oil on board (load-on-top)[3] subject to certain, yet unspecified, discharge criteria. This advance notice of rules-making has not yet been followed up by publication of rules and regulations on vessel designs.

Title II of the Ports and Waterways Safety Act recognizes the need for and advantages of international agreement on ocean pollution standards. It requires the Coast Guard to submit proposed U.S. regulations to the International Conference on Marine

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Pollution of the Inter-governmental Maritime Consultative Organization (IMCO), scheduled to take place in October 1973. It further requires the Coast Guard to put the U.S. regulations unilaterally into effect no later than January 1, 1976, in case the IMCO Conference fails to reach agreement.

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Regulation 11 specifies the operating methods "appropriate" for compliance with the discharge standard stated in Regulation 9. The three methods specified are (a) segregated ballasting, (b) "load on top," and (c) in-port disposal to shore-reception facilities.

From the viewpoint of this paper, the most controversial provision of the Draft Convention is Paragraph (2) of Regulation 11 which would require all new tankers of 150,000 tons and above, contracted on or after January 1, 1978, or delivered on or after January 1, 1981, to be "designed, constructed and equipped" for segregated ballasting in accordance with specifications provided in Regulation 13. This requirement is consistent with the U.S. Coast Guard's proposal to permit existing tankers and small new tankers to practice load-on-top, but *requires* large new tankers to be constructed for segregated ballasting.

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In practice, however, the underlying data for Step (6) above are particularly lacking. The only available estimate pertains to the economic cost to the United States of ocean pollution in 1971. In the analysis to be presented below, that estimate has been projected to 1980 and used in Step (7).

Note also that the underlying data refer to various types of segregated ballasting. For simplicity, only two types, the single-skin[6] and double-bottom methods, will be selected for analysis. They should, nonetheless, provide a sufficient idea of the differential impacts of using different types of segregated ballasting.

The derivation of estimates is presented step by step as follows.

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It is reported that at the beginning of 1973 a total of 533 tankers were under construction with an aggregate capacity of 88.2 million deadweight tons (DWT). Of this total, 276 are said to be more than 175,000 DWT each.[7] It may not be too far wrong, therefore, to guess that there are about 300 tankers of 150,000 tons or above now under construction.[8] That number — 300 tankers — however, is not what we need, for, as noted above, neither the Draft IMCO Convention nor the proposed U.S. Coast Guard rules-making requires segregated ballasting on tankers now under construction. The number is to be used merely as a stepping stone in further calculations.

In another study, it is estimated that, in order to satisfy 90 per cent of the projected tanker demand in 1980, it will be necessary to construct 8,100 tankers of T-2 equivalents in addition to what are already contracted for construction.[9] Given the capacity of a T-2 equivalent as 16,600 DWT, this implies a projected additional tanker demand of 134.5 million DWT. If we assume that about the same proportion of this demand will be met by tankers in the "150,000 DWT or above" class as that which the 300 super-tankers bear to the aggregate capacity of 88.2 million DWT now under construction, we may estimate that about 450 additional super-tankers will be contracted for 1980 or earlier delivery.

Given the rising trend towards the construction of larger tankers, the estimate might be thought to need an upward adjustment. Note, however, that both the Draft IMCO Convention and the proposed U.S. rules-making would not impose segregated ballasting until several years later. Hence, the number, 450 tankers, will be taken without further adjustment as a rough guess of the number of tankers that would be affected by the IMCO and U.S. requirements between now and the year 1980.

(2) Reduction of Oil Spillage Per Ship

A large amount of data has been gathered by the U.S. Coast Guard and the U.S. Maritime Administration on the incremental effects of adding segregated ballasting to base ships of various sizes, ranging from "handy tankers" of 21,000 tons to "super-tankers" of 500,000 tons. The data are summarized in Table 1 for the single-skin method and the double-bottom method, respectively.

Before examining the data, a couple of remarks on the nature of the data might be helpful. First, the data obtained from the U.S. Coast Guard and U.S. Maritime Administration studies are apparently derived from independent sources. The latter are said to be based on data compiled for the U.S. tanker-construction program. The former are said to be at least partly based on quotations by Japanese shipyards. Hence, any consensus that might arise from this data could be accorded with greater credibility than otherwise.

Secondly, in both studies, the data on reduction per ship were derived by adding up estimates of reduction in "operational spillage" and those of "accidental spillage." The former refer to reductions because tankers equipped with segregated ballasting would be using clean ballast.[10] The data for accidental spillage, on the other hand, are derived by multiplying estimated reductions in the likelihood (or extent) of accidental oil spillage because of segregated ballasting with the average amount of accidental oil spillage by tankers in their respective size classes. In short, the data appear to have been derived by tanker experts with meticulous care, using a considerable amount of raw data at their disposal.

On the basis of the data summarized in Table 1, and bearing in mind that compulsory segregated ballasting would be applied to *large* new ships only, one may estimate that the single-skin method would bring about an incremental reduction of oil spillage of about 50 cubic meters per ship per year and the double-bottom method about 150 cubic meters per ship per year, which can be converted into approximately 43 and 130 metric tons per ship per year, respectively.[11]

(3) Total Reduction in Oil Spillage in 1980

By multiplying the estimated 450 tankers affected by the segregated ballasting requirement, obtained in (1) above, by the estimated 43 and 130 metric tons per ship per year reductions, obtained in (2) above, one can readily estimate the total amounts of reduction of oil spillage of 1980 resulting from the single-skin and the double-bottom methods to be 19,000 and 58,000 metric tons, respectively.

(4) Estimated World Oil Pollution of the Sea in 1980

How significant a reduction these estimates would be will depend on the estimated extent of potential oil pollution of the sea for the year 1980. It has been estimated that the total oil pollution of the ocean during 1969-1970 amounted to about 4.9 million metric tons per year, of which 1.4 million metric tons could be attributed to tankers and 3.5 million metric tons to other sources.[12] These figures will need to be projected to the year 1980.

According to the U.S. Coast Guard, a recent British study: "The Environmental and Financial Consequences of Oil Pollution from Ships" estimates that, given the present condition of about 80 per cent of world tanker tonnage practicing load-on-top, *operational* oil discharge from tankers will increase from 635,000 tons in 1970 to 1,618,000 tons in 1980, or by about 155 per cent. Applying the same rate of increase to the estimated 1.4 million metric tons of tanker oil spillage in 1970 cited above, one obtains an estimated oil spillage by tankers of about 3.5 million metric tons in 1980. Oil pollution from non-tanker sources is not likely to increase as fast as that from tankers.[13] Assume that it will rise half as fast. The resultant estimate of oil pollution from non-tanker sources in 1980 is 6.2 million metric tons. Thus, it is estimated that the total oil pollution of the ocean in 1980 would amount to nearly 10 million metric tons.

(5) Incremental Technical Effectiveness of Requiring Segregated Ballasting

The estimates derived in (3) and (4) above imply that compulsory segregated ballasting would bring about only 0.2% and 0.6% reduction in oil pollution of the sea in 1980, with the single-skin and the double-bottom methods respectively.

These are indeed very small reductions. However, that is not all; oil pollution of the ocean is only a fraction of the total concern over marine pollution. Other sources are river-borne pollution, air-borne pollution, and ocean dumping. Moreover, the various sources of ocean pollution affect the ocean ecology and human welfare in various ways and to various extents. Present knowledge on that is dolefully limited. In general, however, it may be stated that pollution closer to the coastal areas affects human welfare to a greater extent than that occurring farther out in the ocean. Note in this regard that existing international conventions already prohibit operational oil discharge within 50 nautical miles from the nearest shore. It may be assumed that the oil discharge to be prevented by requiring segregated ballasting would occur mostly out in the ocean.

Taking into account both the locational factor and, more importantly, the consideration of other sources of oil pollution, one may arbitrarily assume that the welfare impact of compulsory segregated ballasting might be about one-fifth of its incremental technical effectiveness in 1980. That is to say, the impact would be about 0.4% and 0.12% of whatever the welfare cost of ocean pollution might be in 1980, for the single-skin and the double-bottom methods, respectively.

Table 1. INCREMENTAL EFFECTIVENESS OF SEGREGATED BALLASTING: SINGLE-SKIN AND DOUBLE-BOTTOM

(cubic meters per year; percentage reductions)

		Segregated Ballasting [2]			
Vessel Size [1] (Thousand deadweight tons)	Base-Ship Oil Discharge [2]	Single-Skin Reduction	(%)	Double-Bottom Reduction	(%)
21	60	8	(13)	33	(55)
35[3]	136	15	(11)	57	(42)
75	92	12	(13)	58	(63)
89[4]	85	—	—	63	(74)
120[5]	119	—	—	69[6]	(58)[6]
225	409	45	(11)	155	(38)
250	252	59	(23)	166	(66)
265	480	53	(11)	183	(38)
380	685[7]	75	(11)	261	(38)
500[5]	496	111	(22)	—	—
From IMCO Study I, Part 1:					
120	120A	—		120C	
250	250A-IMCO	250E1		250B2	
500	500A	500E1		—	
From IMCO Study I, Part 2:					
21	D21A	D21E45		—	
75	D75A	D75E		D75B	

Sources: (1) U.S. Department of Commerce, Maritime Administration, Final Environmental Impact Statement: Maritime Administration Tanker Construction Program. N.T.I.S. Report No. EIS 730725-F (hereinafter as the "MarAd Study"), pp. IV-30, VI-53, VI-56, and VI-82.

(2) "IMCO Study I," Part 1, pp. 7 and 83; Part 2, pp. 9 and 76.

Notes: 1/ All test ships are identified by code numbers in the two-part IMCO Study I. The data in this and subsequent tables pertain to the following test ships:

Test ships in the MarAd study are identified only by size.

2/ Ballasting at 45% of full-load displacement.

3/ Base-ship is "product tankers" carrying refined petroleum products. Cargo tanks must be cleaned after every trip, rather than every third trip for the other base ships. Also, small tankers are normally used on short runs, thus making more trips per year. Hence, the large base-ship oil discharge.

4/ Base-ship includes double-bottom.

5/ Data shown are derived from IMCO Study I, Part 1, pp. 53 and 80, by adding operational discharge to accidental discharge, by assuming 7 voyages per year and that accidental discharges are in proportion to size (data on accidental discharge being available only for the 250 series).

6/ Double-sides and double-bottom.

7/ Mid-point in basic data.

(pp. 143, 144)

(6) Estimated Economic Cost of Ocean Pollution to the United States in 1980

The analysis up to this point already suffices for pointing to the conclusion that compulsory segregated ballasting would bring out only negligible reduction in ocean pollution in 1980. However, in order to compare with its incremental costs, it is necessary to attach some dollar value to the reduction.

As stated above, to this author's knowledge, the only carefully-documented estimate that has been made of the economic cost of ocean pollution is that by Dennis P. Tihansky of the U.S. Environmental Protection Agency. His estimate is for the economic cost to just the United States for the year 1970. Tihansky sums up his estimates of the costs of U.S. commercial fishing, navigation, and seashore recreation in 1970 to total from $62 million to $11 million.[14] Let us take the mid-point estimate of $86 million and project it to the year 1980, using the same ratio as the estimated oil pollution in 1980 bears to that in 1970, i.e., 10 million metric tons to 5 million metric tons. The resultant estimated cost of ocean pollution to the United States in 1980 would then amount to about $170 million in constant 1970 dollars.

(7) Estimated Incremental Economic Benefits to the United States in 1980

By multiplying the technical-effectiveness ratios of 0.04% and 0.12%, obtained in (5) above, by the projected economic cost of $170 million, obtained in (6) above, it is estimated that the incremental economic benefits of compulsory segregated ballasting to the United States in 1980 would amount to only $68,000 and $200,000 constant 1970 dollars, for single-skin and double-bottom respectively.

The estimate, of course, pertains to *economic* benefit only. As Tihansky aptly points out in evaluating his own study cited above, the estimation does not capture all the welfare gains of pollution controls. Some consumers may be willing to support pollution controls because they wish to avert any risk of damages to the marine ecosystem, for considerations independent of any economic gains or losses; that is, for philosophical, theological, or aesthetic reasons. These are legitimate concerns and ought to be accorded at least as much consideration as the purely economic gains or losses.

Unfortunately, the non-economic gains or costs are even less quantifiable than economic gains or costs. However, it may not be unreasonable to assume that incremental *non*-economic benefits are also proportionate to the technical-effectiveness ratios derived above, as economic benefits are assumed to be. It can then be concluded that the non-economic benefits of segregated ballasting could not be very substantial either, unless the society were to place exceedingly high non-economic costs to having polluted oceans.[15]

IV. INCREMENTAL COSTS

The conceptual framework for estimating incremental costs is similar to that for estimating incremental benefits, but considerably simpler. Since the number of new larger tankers to be affected by the requirement has been estimated above, and since the per ship increases in tanker-construction cost and in use of steel are available from the same "IMCO Study I" and "MarAd Study" cited above, the total incremental costs in terms of tanker construction cost and of steel usage between now and 1980 can be readily derived. These incremental costs, though of interest to this study, cannot be directly compared to the incremental benefits derived in the preceding section.

For the latter purpose, one would start with estimated increases in "required freight rate," i.e., that which would be required to cover the increases in tanker construction and operating costs, and then apply the rates of increase to the projected U.S. tanker-freight cost in 1980, in order to derive the incremental economic cost to the United States in 1980.

Table 2 presents estimated increases in tanker-construction costs for various tanker sizes and the same two methods of segregated ballasting considered above: single-skin and double-bottom. The data indicate that for large tankers — for example, 225,000 DWT and above — the cost increase for single-skin would be about $4 million and that for double-bottom about $7.5 million, above the base-ship price. When multiplied by the estimated 450 large new tankers affected by the policy, these estimates imply that the incremental tanker-construction costs would be $1.8 billion and $3.4 billion for the single-skin and the double-bottom methods, respectively, between now and 1980.

Table 3 presents estimated increases in the use of steel for single-skin and double-bottom. They indicate that an additional 1,500 tons per ship would be required for single-skin and 5,000 tons per ship for double-bottom. By multiplying these figures with the estimated 450 large new tankers to be built prior to 1980, one arrives at an estimated 0.7 million tons or 2.2 million additional tons of steel to be spent on tanker construction for segregated ballasting.

Table 4 presents estimated increases in the required freight rate. An estimate based on the data is that the freight rate would rise by about 4% for single-skin and 8% for double-bottom. It is estimated that U.S. imports of petroleum in 1972 amounted to 240 million tons.[16]

If, from Table 4, it is assumed that freight cost was about $6 per ton, the total U.S. tanker-freight cost in 1972 probably amounted to $1.4 billion. U.S. imports of petroleum are expected to rise rapidly in the 1970's. Let us assume that imports will be doubled between 1972 and 1980, so that U.S. petroleum imports in 1980 might be about 500 million tons, and tanker-freight cost about $3 billion in constant 1972 dollars.

Now, a 4 per cent or 8 per cent increase in freight cost due to segregated ballasting would imply an increase in U.S. tanker-freight cost alone of $120 million or $240 million in 1980.

The estimated incremental costs are so disproportionately larger than the incremental economic benefits derived in the preceding section that it would be hard to escape the conclusion that compulsory segregated ballasting would not be warranted. Moreover, it also appears very unlikely that any reasonable adjustments in the underlying data or considerations of non-economic benefits would significantly alter the qualitative conclusion of this study.

FOOTNOTES

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[1] Very briefly, segregated ballasting in double bottoms is generally accepted as an effective method for reducing marine oil pollution for the following reasons: (a) It nearly totally eliminates intentional oil spills resulting from ballasting. After oil tankers have unloaded their cargoes at the destination port, they need to fill the tanks with sea water to between 30 to 60 per cent of their full-load capacity — depending on tanker size and weather conditions — for stability of the ship on the return trip. Since oil cannot be completely pumped out from the cargo tanks at the destination port, the resulting mixture of sea water and oil residue form an oil ballast, which must be dumped before the ship can take on oil at the embarkation port. Segregated ballasting means specially constructed capacity for ballasting only, thus nearly eliminating mixture of oil and sea water for ballasting purposes. (b) It reduces accidental oil spills resulting from tanker groundings. Segregated ballast on double bottoms provides additional protection against oil pollution, in that when the ship's outer bottom is ruptured during grounding, no oil will be spilled into the ocean so long as the inner bottom remains intact.

[2] Federal Register. 38(17):2167, January 1973.

[3] The load-on-top (LOT) method consists of collecting the oily-water ballast in slop tanks, letting the heavier sea water settle at bottom, releasing the latter to the ocean, and then at port, loading oil on top of the oil residue left in the slop tanks.

[4] IMCO. Draft Text of an International Convention for the Prevention of Pollution from Ships, 1973. (Report of the Preparatory Meeting to the Maritime Safety Committee, PCMP/83.) March 1973.

[5] For existing tankers and for new tankers of less than 100,000 deadweight ton of displacement. For larger new tankers, the limit would be less than 1/30,000 of cargo.

[6] In contrast to double-bottom segregated ballasting, which was explained in (1) above, the single-skin method achieves segregated ballasting by reserving tanks on both sides of the ship strictly for ballasting purposes (sometimes referred to as "wing tank" ballasting.)

[7] U.S. Department of Commerce, Maritime Administration. Final Environmental Impact Statement: Maritime Administration Tanker Construction Program. NTIS Report No. EIS 730725-F (hereinafter cited as "MarAd Study.")

[8] The level being that which is set by the Draft IMCO Convention for compulsory segregated ballasting.

[9] U.S. Coast Guard. Report on Segregated Ballast Tankers: A Note by the United States of America, submitted to the IMCO as Study 1 in a series of nine studies requested by the IMCO Sub-Committee on Marine Pollution, June 1972, IMCO Document MP XIII/2a/2 (hereinafter cited as "IMCO Study I, Part 1"), p. 78. A subsequent study by the same agency, Ballast Aboard Product Tankers and Smaller Crude Carriers, Report on Part 2 of Study I, February 1973, will be referred to hereinafter as the "IMCO Study I, Part 2."

[10] Some operational spillage would still remain on account of periodical tank washings that are still needed for the oil tanks.

[11] Using the conversion factors in the MarAd Study, p. xxi.

[12] Joseph D. Porricelli, Virgil F. Keith and Richard L. Storch. Tankers and Ecology. In: Transactions of the Society of Naval Architects and Marine Engineers. 79:169-221, 1971. Note p. 172.

[13] The major non-tanker source is automobile oil from oil changes poured into the ground, eventually seeping into the ocean. Its rate of increase will depend on the rate of increase in oil consumption, which can be expected to rise less rapidly than oil imports, assuming a slower rate of expansion of domestic oil supplies than oil consumption.

[14] Dennis P. Tihansky. An Economic Assessment of Marine Water Pollution Damages. In: 1973 Pollution Control in the Marine Industries, Proceedings of the Third International Conference on Pollution Control in the Marine Industries, June 1973. Thomas Sullivan (ed.). Washington, D.C., International Association for Pollution Control, 1973. p 284-324, note p. 304.

[15] Note, however, that even in that case, the magnitude of the non-economic benefits should not be exaggerated, as the proportionality assumption does introduce an upward bias to the estimate of the incremental benefits. An element of nonlinearity is involved here, in that a slightly cleaner ocean might still be a dirty ocean, offensive to all tastes and seriously detrimental to economic interests. A slight improvement might mean little improvement, if any at all.

[16] The British Petroleum Co., Ltd. BP Statistical Review of the World Oil Industry. London, 1972. p. 10.

Table 2. INCREASE IN REQUIRED FREIGHT RATE (RFR)[1] DUE TO SEGREGATED BALLASTING

(dollar per long ton; percentage increases)

Vessel Size (Thousand deadweight tons)	Base Ship RFR	Segregated Ballasting			
		Single-Skin		Double-Bottom	
		Increase	(%)	Increase	(%)
21	8.20	0.20	(2.4)	0.95	(12)
75	8.08	0.26	(3.2)	0.73	(9.0)
120	6.57	—	—	1.33[2]	(20.4)[2]
250	5.36	0.22	(4.1)	0.44	(8.2)
500	5.07	0.42	(8.3)	—	—

Sources: The IMCO Study I, Part 1, pp. 35-36, and Part 2, pp. 30-31.

Notes: 1 For long voyages and zero tax.
2 Double-sides and double-bottom.

Table 3. INCREMENTAL CONSUMPTION OF STEEL DUE TO SEGREGATED BALLASTING

(long tons per ship; percentage increases)

Vessel Size (Thousand deadweight tons)	Base Ship Use of steel	Segregated Ballasting			
		Single-Skin		Double-Bottom	
		Increase	(%)	Increase	(%)
21	3,957	160	(4.0)	831	(21)
75	12,171	615	(5.1)	1,404	(11.5)
120	16,972	—	—	7,447[1]	(44.1)[1]
250	31,659	2,074	(6.6)	5,874	(18.6)
500	56,922	10,157	(17.8)	—	—

Sources: The IMCO Study I, Part 1, p. 103, and Part 2, p. A5.

Note: 1 Double-sides and double-bottom.

Table 4. INCREMENTAL CAPITAL COST OF SEGREGATED BALLASTING: SINGLE-SKIN AND DOUBLE-BOTTOM

(millions of dollars; percentage increases)

Vessel Size (Thousand deadweight tons)	Base Ship	Segregated Ballasting			
		Single-Skin		Double-Bottom	
		Increase	(%)	Increase	(%)
21	8.0	0.18	(2.3)	0.95	(12)
35	20	0.60	(3)	2.60	(13)
75	14.7	0.53	(3.6)	1.8	(12.2)
89[1]	28.5	—	—	—	—
120	20.1	—	—	4.6[2]	(23)[2]
225	65	3.90	(6)	7.15	(11)
250	37.7	1.6	(4.2)	3.3	(8.8)
265	71	4.30	(6.1)	7.80	(11)
380	95	7.15	(7.5)	(0.50)	(11)
500	65	5.8	(8.9)	—	—

Sources: The MarAd Study, p. VI-83; the IMCO Study I, Part 1, p. 107, and Part 2, p. A8.

Notes: 1 Base ship already includes double-bottom. Cost data are, therefore, inapplicable.
2 Double-sides and double-bottom.

THE ENERGY CRISIS: HOW TO SURVIVE UNTIL WE RUN OUT OF OIL

BY

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The energy crisis is not really a shortage of energy; it is a shortage of oil. As long as the sun is shining, we have no energy crisis. What we do have is the problem of misallocating resources. Instead of deriving energy from renewable supplies such as the sun, we are rapidly burning our limited stocks of fossil fuel. In this way, our society has created a double problem: an energy shortage and a shortage of raw materials essential to the manufacture of medicines, plastics, and many other ingredients.

What are the solutions to the energy crisis? The permanent solution is to eliminate the use of nonrenewable energy supplies. Even though we could go a long way in this direction with present technology, it would still take years to implement the changeover. In the meantime, there is another solution, but one which we cannot follow now because of cultural constraints. The solution is simply to reduce consumption. We are going to have to do this sooner or later; we cannot double consumption every ten or fifteen or twenty years on a finite earth.

One of the ways that we can reduce our consumption is to phase out wasteful, energy-intensive modes of transportation. Twenty-five per cent of the demand for oil is for transportation. What is a wasteful mode of transportation? Generally, anything that runs on rubber rather than rails is wasteful. Something that is very fast is wasteful. Something that is powered by non-animal energy is wasteful. We ourselves, of course, can be used for motive power. For walking, we use an average of 300 BTU's per passenger mile. A bicycle uses 180 BTU's. The next most efficient mode is a bus, which uses 21,000 BTU's per passenger for a fully-loaded, 50-passenger bus. The automobile is notoriously inefficient. Even when considering a load factor of five passengers per car, we burn 81,000 BTU's per passenger mile. The only passenger carrier that exceeds that level of inefficiency is a jet aircraft which uses 84,000 BTU's. According to these figures, the bicycle is the most efficient mode of transportation, but it does require a segregated roadway.

Bikes and bikeways are gradually becoming respectable in the eyes of governmental agencies in the United States. The battle for recognition of the bicycle as a viable form of transportation rather than a toy has been long and hard in this country which is deeply involved in its passionate love affair with the car. Overseas, the automobile is looked upon more objectively and the bicycle's advantages are well known. Holland and Japan are adding more bikeways every year to their already well-developed networks. In this country, previously car-choked California streets in the cities of Palo Alto and Davis have been given over to growing numbers of enthusiastic bicycle commuters. They find the bike cheaper, faster (over distances of less than five miles), less polluting and more fun than a car.

Another thing we can do is to design appliances to conserve energy. In general, anything automatic (like a self-defrosting refrigerator) is more wasteful of energy than a manually controlled device. Pilot lights in stoves and water heaters can use as much fuel as the cooling or heating itself. Manual lighting with matches can eliminate this waste. Some equipment designs are inherently more inefficient than others doing the same job. For instance, some brands of air conditioners consume 50 per cent more energy than other models. This brings us to a more fundamental question of why we use air conditioners at all. Americans are very prone to overheating and overcooling their homes. People survive very well in areas such as England where air conditioning does not exist, and homes are heated only to about 66 degrees Farenheit.

The production of manufactured goods is the largest single use of energy in the U.S. today – 40 per cent of the national consumption. This massive devouring of energy is prompted by our materialistic society and the planned obsolescence of the goods we buy. If we bought fewer but better-built items, energy consumption would drop. This would require more hand labor, which in itself will reduce mechanical energy requirements. We have a vast reservoir of energy ready to be tapped: human energy. One of the

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greatest paradoxes of the present day is that we are continually automating with high-energy-use devices and putting humans out of work.

We have discussed some methods for dealing with the problem of over-consumption. How about finding alternate sources for energy besides oil? There are two categories to consider: renewable and non-renewable resources.

The most obvious non-renewable resource is coal. There is enough coal, disregarding other environmental restraints, to keep us running at our present level for 400 to 600 years. The trouble with using coal is that, increasingly, it is being mined by strip mining. Strip mining, environmentally, is totally destructive. It is often claimed that the land used for strip mining can be restored, but the cost of reclaiming that land is about equal to the cost of the coal taken from it. The areas where gold dredges were used in the last part of the 1800's in Alaska have not yet recovered.

The use of oil shales has the same problem; they are strip mined. Another environmentally disruptive attempt to obtain fossil fuels from presently untapped rock is being carried out by the AEC and the oil companies under the Plowshare program. This controversial project, being fought vigorously by the Rocky Mountain state residents involved, hopes to release natural gas by using atomic bombs to break up the rocks which trap it. The few test blasts already held have infuriated local residents who eye with dismay the full-scale development phase. The plan calls for drilling 100 wells per year for 50 to 60 years. On the average, this would require the use of about 370 explosive devices per year, and usually three to four explosives for each well. Spread evenly over the year, simultaneous firing of multiple explosive loads could result in local areas of disturbances as often as every nine days for 50 to 60 years.

Nuclear power is often cited as the alternative to the use of fossil fuel for energy. The only effective use of nuclear power that I can see is fusion — if it can ever be controlled. There are many drawbacks involved with fission power (existing power plants), including thermal pollution, waste disposal, limited supplies of uranium ore, and safety, which make it completely impractical to depend on nuclear energy as a solution to the power crunch.

There is some potential in the use of geothermal power. Geothermal power depends on the fact that the earth is hotter at the core than it is at the surface. If we can drill down or make contact with water which has been heated by the earth's core, this heat can be used as energy. There are some problems, however. The water heated in this manner is often highly laden with salts and other pollutants which have to be disposed of in some way. Treatment of this water for subsequent, non-polluting discharge into waterways can, in itself, require energy as well as space.

Hydroelectric energy does not offer much additional potential in this country because we have already dammed up most of the streams. Furthermore, our strip mining and poor forestry practices have caused our reservoirs to fill up rapidly from added siltation. Hoover Dam has only about another 100 years of operation.

Solar power is a more promising energy source. About 98 or 99 per cent of the energy we use in our homes is originally from the sun, but we are using this energy in a very inefficient way. Essentially, we are using the sun's energy of the Permian or Pennsylvanian age. Our oil and coal, of course, are formed from the decayed remains of ancient plants and animals. Why not use the sun more directly? It is presently technologically possible to do this. Many homes are heated with solar energy. The Japanese have some 2,000,000 solar energy heaters on their roofs. The use of solar energy need not be confined to desert areas or to the beach. Ultraviolet radiation penetrates clouds and only ceases when the sun sets.

Solar energy can also be used for the production of electric power. The cost per kilowatt hour would be astronomical if we used solar cells such as those used in spacecraft. There is a far simpler method, however. The Meinels, husband and wife astronomers at the University of Arizona, are investigating a method whereby the sun can be used to heat water to run a traditional steam generating plant. The Meinels have calculated that they would need a 70-mile-square bank of solar energy collectors to power the U.S. at present energy demand levels. Seventy square miles is, of course, a large area. However, we should take into consideration the fact that the amount of land needed for energy production from strip mining is much larger. Furthermore, the area under the solar collectors is usable grazing land, and the areas could be scattered around the country. An immediate question might be, "What do you do at night?" Excess energy could be stored in pumped storage plants, although this is not a very efficient method. Energy could be stored in molten salts or chemically, such as by use of aluminum oxide which could be converted to aluminum and then oxidized to furnish heat. In short, solar energy looks like a very promising method, although we are doing little research on it. The budget for all forms of solar research was 3.8 million dollars in 1972, as compared to the hundreds of millions used for research into nuclear energy.

Another type of solar power, although indirect, is the conversion of manure into methane. Hog manure, for example, can be fermented to make methane. One pound of manure will produce ten cubic feet of methane. Since there are two billion tons of manure produced each year in the U.S. we could supply about one half of the country's energy requirements from this source alone. I don't think we should use all of this resource for methane, but this is, nevertheless, a completely untapped energy source to consider. There is, furthermore, a disposal problem with regard to manure, so its use for energy would be a double-edged sword.

How about garbage? We are prolific garbage generators. Pound for pound, about half of the amount of energy can be produced from garbage as from coal, which isn't bad. It is not as good a source as coal, but it is better than using it for landfill or incinerating it.

The use of garbage for fuel could save 69 million tons of coal per year.

Why aren't we implementing some of these possible solutions? We aren't because we are being inhibited by the oil industry. The oil industry has overpowering control over our legislatures and legislators to insure the preservation of its production and distribution monopolies. It is very difficult to oppose this power. We must recognize that oil interests own about 23 per cent of the coal companies in the U.S. and are also involved with the business of producing nuclear power. Oil interests have bought much of the non-governmental geothermal reserves in California and are, essentially, controlling energy in the U.S. very efficiently. The oil industry acts as a pusher for us energy addicts and won't let us off the hook. Let me give an example. Proposition 18 would have given the people of California the chance to choose whether the gas tax revenues would continue to be spent for more and more highways or if the funds could be used for mass transit projects, on a local option basis. The oil companies spent millions of dollars on scare advertisements threatening higher taxes if the proposition passed. Proponents had a very limited budget with which to fight the oil interests and the voters were frightened into rejecting the proposition. The result: more freeways, more gas consumption, more profits for the oil companies.

There are some very serious consequences to the "oil at any price" policy. One is already evident: the energy crisis. Whether or not it was manipulated, it is here and it is a direct result of our over-reliance on one energy source. Another serious consequence is the depletion of a very valuable manufacturing commodity by wasting it as a fuel. There is a better use for oil than merely burning it. Oil is a very valuable chemical substance and is the basis for our petrochemical industry. Are we going to bomb Saudi Arabia if they refuse to sell us oil? If the oil industry whips us up into enough of a furor, we might well condone that type of action. If it comes to a choice of bombing Saudi Arabia or freezing all winter, what is the nation going to do?

As an environmentalist, I would like to analyze the battle. The energy crisis is upon us. It already has had the result of raising prices, which skyrocketed the profits of the oil industry. The shortage of fuel has the independents, always a thorn in the side of the major oil companies, up against the wall. Most important to me, the oil companies are using their crisis to bludgeon the government into making environmentally disastrous decisions. Lease sales for offshore drilling are being stepped up, even though the oil industry has never yet been able to demonstrate an ability to contain or clean up oil spills in the open sea in anything but calm conditions. Supporters of the oil industry rammed the Alaska Pipeline bill through Congress and even had enough power to add a section which (probably unconstitutionally) prohibits any further judicial review under the National Environmental Policy Act.

What do we do? Even though Americans have been deceived by the $5 million worth of advertising spent by the American Petroleum Institute last year, as well as by the advertising of individual companies, they still have common horse sense. If we are to survive, it will be common American horse sense which will save us. We have been told over and over to consume, to spend, to want a huge, unwieldy automobile. Common sense, on the other hand, dictates thrift and abhors waste. More and more people are making the decision that our present pollution-producing, high-energy-consuming way of life is not the way they want to live.

Americans, as a people, are getting more sensitive to their surrounding environment. They are forming environmental and consumer groups to force industry, including the oil companies, to look further ahead than next year's profits. When the people succeed, their children and the industries, which will be forced to stop squandering their own stocks of raw materials, will be the beneficiaries.

INTERNATIONAL ACTIVITY RESPONDING TO OIL POLLUTION DAMAGE FROM VESSELS AT SEA

BY
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In May 1967, the Inter-governmental Maritime Consultative Organization (IMCO) began filling the gaps in public international law concerned with marine pollution from vessels. This task was occasioned by the wreck of the *Torrey Canyon*, which had occurred in March of that year. Speculation centered at that time on the probable response of governments to the phenomenon of large-scale oil pollution from ships. Would the loss best lie where it had fallen? Would it be more rational to regard the risks and the realized damage stemming from an essential activity (the carriage of oil) as a financial charge on society as a whole? Should the burden be placed on the taxpayer and consumer?

The international community within the United Nations has since decided these questions. The answer is that since the shipowner is responsible for causing the pollution, he is liable for the resultant damages. He passes the burden on to the cargo owner who, in turn, passes it on to the consumer. The consumer, who is the beneficiary of the activity which causes the harm, simply groans and pays.

We can examine this and other propositions within the context of inter-governmental activity as carried out by the United Nations system. Its purpose is the prevention, control and compensation of vessel-source and other oil pollution. The first international conference on oil pollution occurred in 1926. Over the years until 1967, the response of governments on the international level consisted solely of an effort to prevent *intentional* pollution of the sea. Since 1967, the problem of *accidental* pollution has been dealt with. *Intervention* on the high seas has been added as a novel rule of public international law, and *compensation* for oil pollution damage has been given substantially wider meaning in private law remedies arising from treaties.

How far-reaching and responsive are these activities? What influences guide their formulation, and how effective are they likely to be? Are they genuinely victim-oriented?

I return to the consumer who groans and pays. Perhaps he groans because he is not a paying consumer but also a victim of the activity. For example, he might be the owner of a beachfront hotel who suffers as much if not more from the importation of hydrocarbon oils as from the benefits of that activity.

We have been forcefully reminded during this symposium of our dependency on oil and the transportation factor involved in its acquisition. One alternate method of handling the problem was suggested during the symposium, the return to a bucolic economy. The other day on the BBC in England, a commentator with what could be called a "straight voice," suggested that if London returned to the horse and carriage, Piccadilly would soon be under 14 feet of manure!

At present, the oil and shipping industries supply a need for which we can see no encompassing alternatives. Therefore, a second need exists: effective law and practice to guide and control these activities. In this connection, another proposition is open for appraisal. It is that *prevention* of pollution from ships is a front-line, inter-governmental response; cleanup and compensation are not. A platitude? Yes and no. You will have observed that the emphasis in the "Corporate Response" segment of this conference stressed the latter factors. However, it should be equally emphasized that the training of the Master and the crew of a Very Large Crude Carrier (VLCC), the safety of her navigational and other equipment, the openness of the route she must travel — all aspects of life and property safety at sea — are primary considerations. The booms, the barges, the detergents are all necessary, but these are the appurtenances of failure.

At present, an actual polluting casualty involving a jumbo tanker may or may not have occurred. The task ahead is to keep such casualties always in the future. Looking to the future tanker commerce as has been depicted by the charts provided by Shell Oil, one might well ask how the prevention of oil pollu-

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tion on the catastrophic scale can be indefinitely staved off.

The answers have been touched on already: technically sound and effectively enforced safety regulations for shipping (navigational equipment, traffic separation schemes, crew training, etc.) and powerful financial incentives for the shipping and oil industries to keep the VLCC's afloat and the sea clean. The regimes of safety include:

1) the International Convention for the Prevention of Pollution of the Sea by Oil, 1954/62 and any successor treaty;

2) the International Convention for the Safety of Life at Sea, 1960;

3) the International Convention on Load Line, 1966;

4) the International Regulations for Preventing Collisions at Sea, 1960 and any successor treaty;

5) the amendments to these instruments adopted from time to time;

6) the International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969.

These regulatory regimes and the back-up systems for liability and compensation require concerted international efforts at uniformity of application. Looked at critically, what have nations really accomplished in the advancement of international measures suitable to an environmentally-conscious world? There is no doubt that these treaties and their day-today applications have enormous value in the protection of the environment. But they are based entirely on the cooperative spirit of inter-governmental collaboration, and their enforcement is almost exclusively a matter of flag-state authority. This by no means implies that nations in many other forms of enterprise are willing to set up international cooperative efforts. Although no enterprise in the world is more international in scope than shipping, even in its regulation, the individual state is jealous of the right to prescribe and to regulate the activities of its ships and nationals.

A conference which convenes from October 8 through November 2, 1973, in London is going to examine the draft of a most comprehensive international agreement. It consists of articles and five annexes:

1) Annex I comprises regulations for preventing marine pollution by oil — a consolidation and revision of the existing regime on the subject;

2) Annex II contains regulations for the control of pollution by noxious and liquid substances carried by ship in bulk;

3) Annex III contains regulations for the prevention of pollution by harmful substances carried by the sea in packaged form or in cargo containers or in portable tanks;

4) Annex IV deals with the prevention of pollution of the sea by sewage from ships;

5) Annex V deals with the problem of ships' garbage.

The Conference is the forum for consideration of another draft treaty — a draft Protocol relating to *Intervention* on the High Seas in Cases of Marine Pollution by Substances other than Oil. This latter draft illustrates some of the difficulties which arise on the international level from the deeply ingrained tendency of all legal systems to rest upon certainties. We all know that there *are* hazardous substances other than oil that may escape from ships. The problem is, how do we delineate these substances? Can they be listed? If not, should we simply generalize the matter and let the facts of risk foreseen, or damage caused, speak for the hazardous nature of the individual substance? Since the treaty involves intervention, a right of prior and contingent action on the part of a state to defend its coastline from pollution, the ultimate probable solution is an illustrative list of substances annexed to the treaty. This would be enlarged and amended as necessary, with as much inherent flexibility as possible.

A future task of IMCO will involve the similar extension of the 1969 International Convention on Civil *Liability* for Oil Pollution Damage to other hazardous and dangerous substances. The IMCO Legal Committee is about to grapple with the same defects of uncertainty as in the case of intervention. This matter may seem more difficult and serious to some in its implications, since matters of civil liability require even more prior certainty than the cases in which public intervention must be determined.

The Conference held in Brussels in 1969 which adopted the Civil Liability Convention, was the background for some lively disputes on two main questions: (i) the measure of liability and (ii) on whom it should fall. The concept of strict liability with "channeling" to the shipowner was one solution based on nuclear liability conventions. The division of liability between ship and cargo owners was also debated. A liability with reversed burden of proof (that is, the shipowner bearing the burden to prove he was not at fault) was a popular idea. These and other concepts were discussed in the IMCO Legal Committee and in other bodies having representation by maritime, legal, and insurance interests. Draft treaties were laboriously prepared.

The oil industry had, in the meantime, created TOVALOP (January 1969) as a timely industry response and a suitable initiative to fend off unilateral national law-making of the kind epitomized by recent Florida legislation. Both cargo and shipowners had seen that the potential economic costs of compliance with cleanup and compensation legislation could be large and could spread industry-wide. Cargo, while not being generally thought a suitable subject for "channeling" of liability, was clearly a candidate to bear some of the risk if a treaty system was to be established. The ubiquitous factor in catastrophic oil pollution is, after all, the cargo.

A compromise resulted. The Conference put a burden of strict liability on the shipowner, relieving him only of liability for acts of God and war, third party responsibility for the incident, or governmental negligence. His liability was, however, limited to a figure which is presently the lesser of $160 per gross ton or $16.2 million. This more than doubles the previous liability limitation figure of the 1957 Brussels Convention, an amount which, as we learned in cases like the *Torrey Canyon*, was itself as likely as not to vanish with the ship. In order to enjoy the benefit of limitation of liability to these figures (about the cost of the *Torrey Canyon* cleanup), the shipowner will have to constitute a limitation fund in the jurisdiction where an action is brought.

None of this effectively shifted any burden to the oil industry, and another compromise resulted. The Conference of 1969 resolved to ask IMCO to call another conference to set up a compensation fund. It was thought inescapable to elaborate a system of financial relief for shipowners over and above the 1969 limitation of liability. If not, shipowning nations would not ratify the treaty. The shipowners already regarded themselves as burdened under the 1969 agreement with the highest possible insurable figure.

The Conference resolution, therefore, contemplated a future conference (which was held in the winter of 1971) at which

1) the victims of pollution would be assured of compensation even when the 1969 treaty did not provide it;

2) the shipowner would be relieved of the added burden imposed on him by the 1969 Convention.

The 1969 and the 1971 Conferences therefore created a package agreement. The treaty adopted in 1969, following the pattern established for the nuclear "operator," channels a limited liability to one person — the shipowner. The 1971 Convention relieves both him and the pollution victim of financial burdens through a fund which is alimented by the oil industry.

I might add that in January 1971, the oil industry also set up a new scheme — "The Contract Regarding an Interim Supplement to Tanker Liability For Oil Pollution" (CRISTAL) to provide, on a voluntary basis, reimbursement to tanker-owners and charterers for cleanup costs and to assist victims of pollution damage not otherwise compensated.

The compensation machinery of the 1971 IMCO Fund, very briefly, is activated by a lawsuit of a claimant or shipowner before a court competent to hear an action under the 1969 Convention. It is presumed, of course, that settlement out of court will be possible. This action contains two unique provisions: first, a private party can be compensated by an international fund, and second, an international fund can go before a court in a contracting state "as a party" to legal proceedings. Also, private persons pay contributions into the Fund to create and maintain it.

The working of the Fund includes some interesting features. First, it is necessary under the system created by the two treaties that the "pollution damage" shall have occurred to the "territory including the territorial sea" of the contracting state. The word "pollution damage" is somewhat broadly defined. Second, it must be pollution from an incident involving one or more ships.

It might be said that there is almost absolute liability under the Fund. Article III (2) of the 1969 Convention is set aside (except for acts of God and war, third parties, or a negligent or wrongful act of government). A claimant bears the burden of proof, but he can recover from the Fund when he cannot recover from the shipowner under the 1969 Convention. Under the latter, the shipowner must be identified and sued. Under the Fund Convention, the claimant only proves that the pollution resulted from a shipping incident which could be liable under the earlier Convention.

A third interesting point relates to incentive. At the vigorous urging of the United States and Canada, and with the support of other nations, the 1971 Conference adopted an Article (5,3) which provides that the Fund is exonerated wholly or partially toward a shipowner (or his guarantor) if it is proved that as a result of personal fault ("actual fault or privity of the owner") the ship did not comply with requirements laid down in the safety conventions previously mentioned. The "fault or privity" provision is an important one, but it must be noted that not all shipowners can be easily found by a claimant. The "filing cabinet" owner or corporation could have very little knowledge, indeed, of what "requirements" are complied with on a ship.

The 1971 Convention is linked to that of 1969 in the sense that the former cannot come into force before the latter, and parties to the Fund treaty must be parties to the 1969 Convention. In many ways, the complementary instruments make the shortcomings of each less consequential, but it is still maintained by some that the geographical scope of the earlier treaty is too restricted, the amount of available funds too little, and the inducements to prevent pollution too slight.

The Civil Law Convention of 1969 has been signed by 28 states and ratified by four (Fiji, Ivory Coast, Liberia, and Senegal). The Fund Convention of 1971 has been signed by 17 countires and ratified by one, Liberia. Without going into the mechanism for bringing them into force, I can make a prediction based on communications with various states that the Convention will enter into force sometime after July 1974.

Parallel activity in the United Nations is progressing in preparation for a new Law of the Sea Conference. The most noteworthy initiatives in the field of pollution prevention and control are probably being taken in that forum by Canada. In particular, the Canadians are seeking to establish a rule of state responsibility for marine pollution damages.

When states seek solutions on the inter-governmental level, it is usually a major unspoken premise that cooperative effort is favored over unilateral domestic rules of law. The shipping community justifiably depends on the governments of the United Nations system to make every effort to coordinate their laws on pollution from ships. The alternatives need not be pointed to. Suffice it to say that 80 per cent of the world's trade is still carried in ships. International treaty law is an instrument of consensus which, even in the area of ship safety, is neither particularly swift in motion nor comprehensive in application. International law has been called a system which the evil ignore and the righteous refuse to enforce. It is, nonetheless, the best tool we presently have in international relations. It is most effective in a context of an equilibrium of national self-interest. If more and more states recognize the need to protect themselves from the menace of pollution from ships, it may become easier to conclude these agreements, to bring them swiftly into effect and to enforce them.

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*This paper reflects only the opinions of its author, who does not speak in it for the organization he serves.

APPENDIX B:

COMPENSATION FOR OIL POLLUTION DAMAGES

BY

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I. UNDER UNITED STATES ANTI-POLLUTION STATUTES

The federal anti-pollution statutes constitute one body of law applicable to oil pollution liability within United States territorial waters. Since these are the laws which make the discharge of oil illegal and punishable through discharge fines, the anti-pollution statutes may superficially appear to be the best avenue for recovering oil pollution damages. Yet, this preventive aspect of oil pollution protection has only recently been complemented by federal laws outlining the liability for damages following a spill. This belated move in allocating oil pollution liability is largely uncompleted; the statutes merely allocate the financial responsibility for cleanup.

The first important piece of federal legislation applicable to oil pollution was the Refuse Act of 1899, also known as the Rivers and Harbors Act. The Act, a generalized water pollution statute, declared:

> It shall not be lawful to. . .discharge. . .either from or out of any ship, barge, or any floating craft of any kind, or from. . .manufacturing establishment. . .any refuse matter of any kind. . .into any navigable water of the United States.[1]

The discharge prohibition of the Refuse Act was held applicable to oil discharges in *United States v. Standard Oil Co.*[2] (1966). Under the Act, a polluter was liable for a maximum $2,500 fine and one-year imprisonment for an illegal discharge. The interpretation of the Refuse Act found in *United States v. Steamship Santa Tecla*[3] (1922) imposed a strict standard of liability on the polluter. Under this theory of liability, the Justice Department (the enforcement agency of the Act) ordinarily only needs to prove the "fact" (occurrence) and "cause" (source) of the discharge to collect the fine. Few defenses are allowed under strict liability; one such defense is an "act of God" plea, where the extraordinary peril (e.g., hurricane) that caused the spill would preclude any civil fine. Due to the overall strength that this liability standard gives the Justice Department, the Refuse Act of 1899 is still invoked against polluters.

The first piece of federal legislation dealing specifically with oil pollution was the Oil Pollution Act of 1924. This Act declared:

> it is unlawful for any person to discharge. . .oil by any method. . .into or upon the navigable waters of the U.S. . .(except) in the case of emergency imperiling life or property, or unavoidable accident. . .[4]

The Oil Pollution Act of 1924, like the Refuse Act of 1899, provided for a maximum fine of $2,500 and one-year imprisonment. The Act imposed a modified form of strict liability; there were additional "emergency" and "unavoidable" situations where no fine could be collected. These additional situations were only partially defined by the courts before the 1924 Act was superceded in 1966 by the Clean Water Restoration Act.

The Clean Water Restoration Act (CWRA) of 1966 defined an illegal discharge as "any grossly negligent or willful spilling. . .of oil."[5] This definition rendered the Act ineffective, since the government was faced with the difficult task of proving gross negligence on the part of the polluter. However, the Act did contain a new method of dealing with the oil pollution problem; it required that the polluter remove all discharged oil or face liability for governmental cleanup costs. The Clean Water Restoration Act was, therefore, the first piece of federal anti-pollution legislation to declare any type of liability for oil pollution cleanup. Unfortunately, this innovation was also unusable in the CWRA format, due to the difficulty in proving an illegal discharge.

While the Oil Pollution Act of 1924 and the Clean Water Restoration Act of 1966 were primarily aimed at ship discharges, the Outer Continental Shelf Lands Act (1953) was applicable only to structures on the Outer Continental Shelf. It provided that:

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> Any person who knowingly and willfully violates any rule or regulation prescribed by the Secretary (of Interior) for the prevention of waste, the conservation of the natural resources or the protection of correlative rights shall be deemed guilty of a misdemeanor and punishable by a fine of not more than $2,000 or by imprisonment, and each day of violation shall be deemed to be a separate offense.[6]

In addition, the continued violation of conservation-related Department of Interior regulations could result in lease revocation.

Following the highly publicized *Torrey Canyon* and Santa Barbara oil spills, which illustrated the uncertain status of cleanup liability, the Congress passed the Water Quality Improvement Act (WQIA) of 1970 to delineate oil pollution cleanup liability within U.S. territorial waters. The Water Quality Improvement Act has since been incorporated into the Federal Water Pollution Control Act (FWPCA), which supercedes WQIA.

FWPCA (Public Law 92-500, October 18, 1972) has been the most comprehensive federal legislation to date that deals with oil pollution.

Section 311(b)(1) of FWPCA gave the Congressional declaration of policy in regard to oil discharges:

> The **Congress** hereby **declares** that it is the **policy** of the United States that there should be **no discharges of oil** or hazardous substances into or upon the waters of the contiguous zone. (Emphasis added.)[7]

This zero discharge policy was slightly modified by the actual codification of prohibited discharges, contained in Section 311(b)(3):

> The **discharge of oil** or hazardous substances into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone in harmful quantities as determined by the President under paragraph (4) of this subsection **is prohibited, except** (A) in the case of such discharges of oil into the waters of the contiguous zone, where permitted under article IV of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, as amended and (B) where permitted in quantities and at times and locations or under such circumstances or conditions as the President may, by regulation, **determine not** to be harmful. (Emphasis added.)[8]

The determination of harmful discharges of oil was delegated by the President to the Environmental Protection Agency (EPA). The EPA regulations dictated that any oil discharge that would "cause a film or sheen upon or discoloration of the surface of the water"[9] would be a prohibited discharge.

The Federal Water Pollution Control Act is applicable to both vessels and stationary oil facilities. The discharge of oil from such vessel or facility could subject the owner or operator to a maximum fine of $5,000. In addition, the failure to notify the U.S. government, through the Coast Guard, of any discharge within territorial waters could subject the owner or operator to a $10,000 fine or one-year imprisonment. These provisions of FWPCA were similar to the previous federal anti-pollution statutes in that they attempted to control oil pollution through a prevention-oriented system of fines.

However, the Federal Water Pollution Control Act went beyond these provisions; *it established liability standards for cleanup of oil discharges from vessels:*

> Except where an owner or operator can prove that a discharge was caused solely by (A) an act of God, (B) an act of war, (C) negligence on the part of the United States Government, or (D) an act or omission of a third party. . .such **owner or operator** of any **vessel** from which **oil** or a hazardous substance is **discharged**. . .(shall) be **liable** to the United States Government for the actual costs. . .for the **removal of such oil** or substance by the United States Government in an amount **not to exceed $100 per gross ton** of such vessel **or $14,000,000**, whichever is the lesser, except that where the United States can show that such discharge was the result of willful negligence or willful misconduct within the privity and knowledge of the owner, such owner or operator shall be liable to the United States Government for the full amount of such costs. (Emphasis added.)[10]

Similarly, the owners and operators of *onshore and offshore facilities were held liable:*

> for the removal of such oil or substance by the United States Government in an amount **not to exceed $8,000,000** except that where the United States can show that such discharge was the result of willful negligence or willful misconduct within the privity and knowledge of the owner, such owner or operator shall be liable to the United States Government for the full amount of such costs. (Emphasis added.)[11]

Thus, the Federal Water Pollution Control Act created strict liability for oil pollution cleanup to a ceiling of $100 per gross ton (or $14 million) for oil tankers and $8 million for onshore and offshore oil facilities. The traditional strict liability defenses for which there would be no liability for oil pollution cleanup — acts of God, war, governmental negligence, third parties — are valid defenses under FWPCA.

To insure that the liability standards could be met, the Congress instituted a **financial responsibility prerequisite** in FWPCA for any vessel using United States ports:

> Any **vessel** over three hundred **gross** tons. . . using any port or place in the United States for any purpose shall establish and maintain under regulations to be prescribed from time to time by the **President**, **evidence of financial responsibility** of $100 per gross ton, or $14,000,000 whichever is the lesser, to meet the liability to

> the United States which such vessel could be subjected under this section. (Emphasis added.)[12]

Thus, the Federal Water Pollution Control Act has made a significant advance in allocating the basic cleanup costs of an oil spill by declaring that the owner of an oil-discharging vessel be liable for cleanup costs up to $100 per gross ton or $14 million and that facility owners be liable for cleanup costs up to $8 million. The ability of vessel owners to meet this cleanup liability is guaranteed through the financial responsibility requirement. There is no similar evidence of financial responsibility required for onshore and offshore facilities. In effect, FWPCA does not insure that the oil spill cleanup liability is met by the onshore and offshore facility owners.

If, in fact, one aim of the oil pollution section of the Federal Water Pollution Control Act was to provide compensation for the entire oil spill cleanup costs, there are additional inadequacies. The current liability limits for oil discharge cleanup costs may be exceeded in actual oil discharges. For example, estimates on the cleanup of the 60,000 ton tanker *Torrey Canyon* oil spill range from $7.2 to $16 million.[13] Using the low $7.2 million figure, which the American Petroleum Institute documented as the direct governmental cleanup costs, the *Torrey Canyon* owners would only have been liable for $6 million under the FWPCA formula (60,000 tons X $100/ton). Since shipowner liability is the only method for compensating for these cleanup costs, this leaves $1.2 million unaccounted for. This cost would apparently be borne by the government and taxpayers through a federal fund developed under FWPCA to cover initial cleanup costs. Furthermore, if the oil discharge was the legally declared result of an act of — God, war, U.S. government negligence, or third party omission — then there would be no cleanup liability placed on the polluter.

Finally, the Federal Water Pollution Control Act established liability for only the basic cleanup costs. Cleanup may alleviate the basic ecological and economic threat, the spilled oil. But cleanup liability does not provide a basis for compensation claims for damages caused by an oil spill before its cleanup. Thus, the federal anti-pollution statutes offer no basis for compensation for oil pollution damages other than cleanup.

II. CONCEPTS OF TORT LIABILITY

Since the federal anti-pollution statutes preclude any compensation for oil pollution damages to private citizens, these claimants usually seek relief in the federal courts under concepts of tort liability. The federal courts have been charged with the responsibility for adjudicating disputes of substantive maritime or navigation-related law. This power is derived from Article II Section 2 of the United States Constitution and the Judiciary Act of 1789:

> . . .the district courts. . .shall also have the exclusive original cognizance of all civil causes of admiralty and maritime jurisdiction. . .saving to suitors, in all cases, the right of a common law remedy, where the common law is competent to give it.[14]

In construing the maritime laws, the courts have necessarily borrowed from the common law tort principles of negligence, trespass and nuisance. These torts or civil wrongs are the basis for suits in which a private citizen can sue for compensation for oil spill damages.

Until 1948, there was no remedy available for the pollution damages which occurred on land as a result of an ocean spill, such as the fouling of a resort beach. This gap in maritime law, created by the inability of the courts to consider "ship-to-shore tort" cases, was filed by the Admiralty Extension Act of 1948:

> The Admiralty and maritime jurisdiction of the United States shall extend to and include all cases of damage or injury to person or property, notwithstanding that such damage or injury be done or consummated on land.[15]

Since 1948, the federal courts have had jurisdiction to consider the full spectrum of oil pollution damage compensation cases brought by private citizens through interpretation of the common law torts.

Negligence, defined as "conduct which falls below the standard established by law for the protection of others against unreasonable risk of harm,"[16] has been the principle basis for oil pollution damage suits. In a negligence action, the plaintiff is normally required to prove:

1) that the defendant owed a duty to the plaintiff,
2) that the defendant breached this duty through some act or omission,
3) that actual loss or damage resulted to the plaintiff; damage was the defendant's act or omission.[17]

Under a negligence claim, the defendant may breach in his duty not to discharge harmful quantities of oil by an intentional act or oversight. Although this breach of duty may be provable ("Past experience has shown. . .that most oil spills occur because of provable negligence or intention")[18], it is normally beyond the means of the private citizen to prove that the defendant was negligent.

> As a practical matter, it is virtually impossible to prove negligence on the part of the owners of the tanker. The problem of proving faulty construction of a tanker built, perhaps, in Japan, Germany, Norway or Greece, or faulty seamanship by a vessel flying the Liberian or Panamanian flag and carrying a multi-national crew, is beyond the ability of a property owner whose shoreline is ruined by oil spillage.[19]

Realizing the difficulty the private citizen has in bearing the burden of proof for negligence, some courts have allowed recovery under a different theory of negligence. Under the *res ipsa loquitar* ("the thing speaks for itself") situation, the defendant is presumed negligent after the plaintiff proves the fact of his injury. The burden of proof is thus switched to the defendant, who, in order to avoid liability, must prove that he was not negligent. This theory changes the complexion of the financial and evidencial burdens that a private citizen bears in undertaking a suit, but the *res ipsa loquitar* theory is not often allowed and therefore offers no guarantee of quick, equitable compensation.

There is another problem which faces the plaintiff in a normal negligence action: he must prove that the defendant's act was the proximate cause of his damage. The ability of resort owners and related tourist-dependent entrepreneurs to recover for business losses is currently a tenuous procedure hinging on the proof that these losses were the natural result of the spill.

> The law is even more uncertain with respect to recovery by innkeepers and restaurant owners. It is likely that they cannot recover from the merely negligent shipowners for loss of profits due to cancellations by tourists who do not choose to spend their vacations at polluted beach resorts. The legal principle is that there can be no liability for negligent interference with contractual rights. The policy arguments behind this are that this risk of pecuniary loss could not be foreseen by a negligent defendant, whereas risks of property damage and physical injury might well be foreseen and that proof of lost profits would be too speculative. However, many courts now allow proof of lost profits in circumstances where it was formerly denied if the plaintiff can prove the loss to have been proximately caused by the defendant regardless of the speculative nature of the proof. Where the hotel-keeper is the owner of a beachfront resort which suffers pollution damage, he will be in a stronger position, not because of logic but because of history. He may successfully argue that a loss from cancellations was merely consequential to the writ of trespass or case for property damage. However, where the hotel-keeper or restaurant owner does not have a beachfront he will be faced with the difficult burden of showing that the loss from cancellations was proximately caused by the grounding or collision. The scope of present laws and conventions has been narrowly drawn to exclude reference to those who do not suffer property damage or physical injury as a result of pollution.[20]

Thus, the innkeeper or restaurant owner with an oil-slick-damaged beachfront has an uncertain chance of recovery for lost business profits under the current negligence theory. The entrepreneur across the street has almost no chance to recover under negligence.

Trespass, the second tort on which private compensation for oil pollution damage can be based, had been traditionally actionable for "every unauthorized, unintended, non-negligent entry upon the soil of another. . ."[21] Under such a doctrine, "every voluntary action or enterprise that interfered with land in the possession of another imposed strict or absolute liability upon the wrongdoer."[22] However, this historical treatment of trespass torts which might have provided adequate grounds for damage recovery has been largely replaced by a new view of trespass.

> Unfortunately, for many of today's innocently damaged property owners, under modern tort theory causing an object to enter land is actionable as a trespass, only where it is the result of an intentional intrusion, negligence, or an abnormally dangerous activity.[23]

The courts have yet to declare that the transportation of oil at sea is an abnormally dangerous activity. Moreover, it has been shown that a private citizen has great difficulty in proving negligence since it necessitates proving that the discharge was deliberate. Coupled with these difficulties is the fact that:

> Actual contact with property is a basic element of a trespass claim, and trespass thus would not seem useful to a littoral property owner who suffered loss from the pollution of waters adjacent to his property, but whose actual property damage was less significant or non-existent.[24]

Thus, to beachfront resort owners, neighboring restaurants and other tourist-related businesses not directly invaded by an oil discharge, trespass would seem to fail as a means for recovery for land-based business losses incurred following an oil spill.

On the other hand, modern trespass theory has been found applicable to oil spills that destroy shellfish raised under state leases,[25] since this is an actual property intrusion. Similar circumstances of intrusion may also allow relief under modern trespass theory when all the elements of a trespass action can actually be proven.

Nuisance is the third tort to be considered as the basis for oil pollution damage recovery. Often, cases are not brought under the nuisance doctrine since it is generally believed that nuisance is applicable only to a recurring interference with property rights. However, nuisance may be based on a single instance of property interference. The basis of a private nuisance claim is the disturbance of one's property rights in the use and enjoyment of his land. Liability for a private nuisance may be predicated on an intentional intrusion, a negligence invasion, or an invasion resulting from an abnormally dangerous activity carried on in an inappropriate place. However, for a private nuisance action to be successful, the claimant must show his injury to be "distinct from that of the public at large, in kind, rather than in degree."[26] Thus, a nuisance action may give rise to successful claims to some severely impacted property owners, but it seems to preclude any broad-based payment owing to the "distinct" nature of the doctrine.

Thus, the maritime law interpretation of common law tort principles presents several difficulties for the private claimant damaged by an oil spill. First, the burden of proof is generally on the claimant; he must demonstrate the fact and cause of his negligently caused injury. This is a difficult task considering the complex nature of maritime traffic and the financial assets of the tanker owners. In the event that the spill was not negligently caused, but was caused instead by an act of God (e.g., hurricane), there would be no compensation for the losses incurred. This loss would be directly borne by the private citizen suffering the damage. Finally, private citizen compensation for oil spill damages is complicated by the Federal Limitation of Liability Act of 1851. This Act limits the liability of the owner of a tanker which is involved in an oil spill to the "value of the interest of such owner in such vessel, and her freight then pending,"[27] if the spill occurred without the privity and knowledge of the owner. In the *City of Norwich* (1886) case, the Supreme Court declared that the owner's interest in a vessel was to be determined at the end of each voyage.[28] Thus, if the ship is afloat following an oil pollution disaster, the shipowner could still limit his liability to his share of the ship, assuming successful claims had been filed. If the ship sinks or is otherwise destroyed in value, "and the owner is allowed to limit his liability, pollution claimants may be left without hope of compensation altogether."[29] Therefore, there are currently many potential oil spill circumstances where the private claimant would be unable to garner adequate compensation through liability imposed under the interpretation of maritime tort law.

III. INTERNATIONAL CONVENTIONS

The lack of guaranteed compensation for demonstrable oil pollution damage offered by federal antipollution statutes causes us to turn our attention to international law as a basis for compensation. The transportation of oil between producing and consuming countries has led to the establishment of a complex international network of tanker traffic. Coincident with this network and its movement of petroleum products is the risk of oil spills. The history of oil spills and their resultant pollution has clarified the need for a broad-based, equitable scheme to compensate those who suffer damages, the broadest compensation scheme would be international in scope, thus placing the solution on the same order of magnitude as the problem. Despite this need for an international oil pollution damage compensation scheme, none currently exists. There are, however, two recent international conventions that if ratified would do much to insure compensation to deserving oil pollution claimants.

The United States was among the first nations to realize that oil pollution was an international problem. In 1922, Congress passed a joint resolution requesting the President to call a conference on oil pollution abatement. This conference was finally held in Washington in 1926. Although the U.S. introduced wide-reaching recommendations on international control, including the "absolute prohibition against discharge of oil at sea,"[30] they were rejected by the conference. The conference did act favorably on a 50-mile prohibited discharge zone surrounding coastlines, but even this failed to achieve the ratification necessary for enactment. Following this meager beginning, there was no international response to the problem of oil discharges for almost 30 years.

The framework for an international agency concerned with oil discharges was set up by the United Nations at the Convention on the Inter-governmental Maritime Consultative Organization, held in Geneva on March 6, 1948. According to the Convention, the Inter-governmental Maritime Consultative Organization (IMCO) was to be concerned with "questions. . . affecting shipping engaged in international trade, including safety. . .".[31] However, IMCO's power to deal effectively with oil pollution was severely limited by the Convention's definition of its role as "consultative and advisory,"[32] which gave it no real enforcement power. It was not until ratification of the Convention in 1957 that IMCO became functional.

Between the creation and ratification of IMCO, a second convention was held at the request of the United Kingdom to discuss oil pollution problems. The 1954 International Convention for the Prevention of Pollution of the Sea by Oil[33] was attended by delegations from 32 countries and observers from ten more. The Convention did not consider oil pollution liability; instead, it dealt with oil pollution prevention regulations. The main points of the 1954 Convention can be summarized as:

1. Most oil discharges were prohibited within a 50 mile zone from shore, with greater prohibited zones in some areas.
2. Illegal discharges were made punishable by the ship's flag state (country of registration); its punishment could not be less than if the ship were in its own territorial waters.
3. Bilge discharges and discharges needed to prevent injury to the ship or crew were allowed.
4. An oil record book was required; all discharges were to be recorded and the book could be inspected at port.
5. Oily water separators for controlling bilge discharges were required on ships, and facilities for receiving oily wastes were to be provided in major ports.

The 1954 Convention was ratified by the required number of countries in July 1958. Although this put the Convention into effect for the signatory countries, the United States did not become a party to the Convention until it signed in 1961.

Shortly after the ratification of the 1954 Convention of the Prevention of Pollution of the Sea by Oil, the IMCO Assembly met in January of 1959 to accept responsibilities accorded to it and the United Nations by the Conventions. During its first years, IMCO was slow in becoming involved in oil pollution matters. This may be partially due to insufficient funding, for "IMCO is budgeted only $1 million per year — lowest of the United Nations specialized agencies."[34]

IMCO did, however, convene and draft the 1962 International Convention for the Prevention of Pollution of the Sea by Oil,[35] held in London with 42 accredited representatives and 14 observers. During the Convention, a number of amendments were proposed to clarify and strengthen the 1954 Convention. These amendments, signed by the United States in 1966 and ratified by the requisite number of countries in 1967, can be summarized as follows:

1. Some of the 50 mile prohibited oil discharge zones were enlarged to 100 miles.
2. Oily waste receptors in ports were more actively promoted.
3. More regulations were included on the content of the oil record book.
4. Discharges were prohibited altogether for ships over 20,000 tons contracted for construction after the convention was in force.

Although these amendments strengthened the important prevention aspect of oil pollution, they did nothing to delineate liability for damages caused by an oil spill.

Following the *Torrey Canyon* disaster off the English Coast, IMCO began to move into the uncertain area of international liability for oil pollution. In May of 1967, the wheels were set in motion for drafting articles for the 1969 International Convention on Civil Liability for Oil Pollution Damage.

The International Convention on Civil Liability for Oil Pollution Damage, 1969[36] met during November in Brussels. The Convention, which was the first international consortium to specify liability for oil pollution damages, had the following provisions:

1. Shipowners were held liable for any oil pollution damage from a discharge within the owner's privity and knowledge, without limitation.
2. Shipowner's liability without fault was limited to the lesser of:
   a. 2,000 francs per gross ton (approx. $160)[37] of the ship, or
   b. 210 million francs total (approx. $16.2 million) unless the discharge was the result of:
      a) an act of war, hostility or insurrection;
      b) an exceptional natural phenomenon (act of God).
      c) an act or omission of a third party;
      d) negligence on the part of any government in providing navigational aids where there would be no imposed liability.
3. A fund and evidence of financial responsibility to meet the liability requirement were required of shipowners.

The success of this Convention, which has not been ratified by the United States and the requisite number of countries to put it into force and which might do much to improve the status of liability for oil pollution compensation through shipowner liability, depends upon the interpretation of the crucial term "pollution damage." Pollution damage is vaguely defined as:

> The loss or damage caused outside the ship carrying oil by contamination resulting from the escape or discharge of oil from the ship, wherever such escape or discharge may occur, and includes the costs of preventive measures (including the actual cost of removal of the oil) and further loss or damage caused by preventive measures.[38]

The courts of countries where pollution damage occurs will ultimately have to determine what may be compensable under the Convention's definition of "pollution damage." Until then, any judgment on the amount of compensation afforded by the Convention would be sheer speculation.

Although the International Convention on Civil Liability For Oil Pollution Damage could be a great step forward in providing compensation for oil pollution damages, there would be deficiencies in adequately compensating for damages in many spill circumstances, even if a liberal interpretation of pollution damages is rendered. First, the 1969 Convention would maintain the traditional defenses of acts of: God, war, third party omission, and governmental negligence. In these cases, there would be no imposed liability and therefore no guaranteed compensation. The adequacy of the increased liability limits has also been questioned. For example, the total claims of the English and French governments following the *Torrey Canyon* spill were $16 million. The *Torrey Canyon*, a 60,000 gross ton tanker, would have been liable for only about $9.6 million under the Convention limit of $160 per gross ton.[39] The imposed liability would be insufficient to cover the government's costs. Additional claims from private citizens for profit loss, fish kills, property use curtailment, etc., could make the total claims significantly larger than the liability limit declared by the 1969 Brussels Convention.

Thus, the 1969 Convention would not provide adequate compensation for oil pollution damages, if ratified. IMCO, desiring to achieve this compensation, established a study group to research avenues for more equitable compensation. The group felt that such compensation was desirable, but that increased liability was not the best means of guaranteeing it. First, there appeared to be insurance ceilings for economically covering any damage liability. IMCO did not wish to seriously disrupt maritime economics by imposing extreme insurance burdens to guarantee compensation. Second, there was a legitimate question as to whether or not the shipowner should bear the liability for damages caused by oil spill occurrences totally beyond his control (e.g., hurricane, tidal wave, sabotage). But, it was felt that the oil spill damage costs should not be shouldered by either the private citizen or his government. Compensation for these damages should be guaranteed by all those who use petroleum products. Therefore, the group decided on an International Fund, supplied on a surtax basis, to compensate oil pollution damage victims. This conclusion was brought to the international forum in the 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage.[40]

If ratified, the 1971 supplementary Convention in conjunction with the 1969 Convention may greatly enhance the prospects of adequate damage compensation. The 1971 International Convention for Oil Pollution Damage provides:

1. The establishment of a central Fund, maintained through port and terminal facility contributions (surtax), to provide compensation for pollution damage victims who have been unable to obtain adequate compensation elsewhere because:
    a. there would be no liability imposed by the Liability Convention for spills caused by acts of: God, war, third party omission and governmental negligence;
    b. the owner would be unable to meet his liability as defined under the Liability Convention;
    c. the damage claims would exceed the owner's responsibility under the 1969 Convention.
2. The only circumstances in which the Fund would not offer compensation for oil pollution damages were if the discharge were the result of an act of war (or similar hostility) or were from a government-owned ship.
3. The compensation available from the Fund for oil pollution damages resulting from one incident would be limited to 450 million francs (approx. $36 million).
4. The Fund would reduce the effective liability of the shipowner. The Fund would reimburse the shipowner for expenses in a no-fault discharge above 150 million francs (approx. $10 million).
5. The maximum compensation available under the Fund could be doubled to 900 million francs (approx. $72 million) by the vote of the Convention parties.

The success of the 1969 International Conventions in providing compensation for demonstrable economic losses rests entirely upon the judicial interpretation of "pollution damage." If a liberal interpretation of pollution damage is rendered by the courts in the vessel's country of registration, then the Conventions would provide the most equitable compensation available under any body of law yet examined. However, these Conventions have not yet been ratified. The Congress is currently weighing its approval for Presidential ratification of the Conventions through bill S. 841. Despite the relief that international ratifications of the Conventions might someday provide, this much is certain: there is currently no guarantee of compensation for oil pollution damage afforded through any ratified international agreement.

FOOTNOTES

[1] The Refuse Act of 1899, 33 U.S.C. § 407, p. 8572.

[2] 384 U.S. 224 (1966), 86 S. Ct. 1427.

[3] 1931 A.M.C. 574 (1922).

[4] Oil Pollution Act of 1924, 33 U.S.C. §§ 431-7 (Supp. 1968).

[5] Clean Water Restoration Act, 33 U.S.C. § 432.

[6] Outer Continental Shelf Lands Act, 43 U.S.C. §§ 1331-43 (1964).

[7] Federal Water Pollution Control Act, Public Law 92-500, § 311 (b) (1).

[8] *Ibid.*, § 311 (B) (2).

[9] "Environmental Protection Agency Regulations on Discharge of Oil," 110.3 (b); quoted in Environment Reporter, Federal Regulations, 131:0901.

[10] Federal Water Pollution Control Act, *op. cit.*, § 311 (b) (1).

[11] *Ibid.*, §§ 311 (f) (2) and (3).

[12] *Ibid.*, § 311 (p) (1).

[13] Douglas Meiklejohn, "Liability for Oil Pollution Cleanup and the Water Quality Improvement Act of 1970," 55 Cornell Law Review, 1970, p. 982.

[14] Judiciary Act of 1789, 1 Stat. 76-77.

[15] Admiralty Extension Act of 1948, 46 U.S.C. § 740 (1964).

[16] Thomas R. Post, "Private Compensation for Injuries Sustained by the Discharge of Oil from Vessels on the Navigable Waters of the United States; a Survey," 4 Journal of Maritime Law and Commerce, (1972), p. 40.

[17] *Ibid.*, p. 40.

[18] Joseph C. Sweeney, "Oil Pollution of the Oceans," 37 Fordham Law Review, (1968), p. 195.

[19] Alfred Avins, "Absolute Liability for Oil Spillage," 36 Brooklyn Law Review, (1970), p. 366.

[20] Sweeney, *op. cit.*, pp. 174-5.

[21] *Ibid.*, p. 170.

[22] Post, *op. cit.*, p. 38.

[23] *Ibid.*, p. 38.

[24] Comment, "Oil Pollution of the Sea," 10 Harvard International Law Journal, (1967), p. 348.

[25] Post, *op. cit.*, p. 39.

[26] *Ibid.*, p. 42.

[27] Limitation of Liability Act of 1851, 46 U.S.C. § 83 (1964).

[28] The City of Norwich, 118 U.S. 468, 6 S. Ct. 1150 (1886).

[29] Post, *op. cit.*, p. 45.

[30] Comment, "Oil Pollution of the Sea," 10 **Harvard International Law Journal**, (1969), p. 323.

[31] Article I, Convention of the Inter-governmental Maritime Consultative Organization, 9 U.S.T. 621, T.I.A.S. No. 4044, U.N.T.S. 3.

[32] *Ibid.*, Article II.

[33] International Convention for the Prevention of Pollution of the Sea by Oil, 1954, 3 U.S.T. 2789, T.I.A.S. No. 4900, 327 U.N.T.S.

[34] Comment, *op. cit.*, p. 334.

[35] Amendments to the International Convention for Prevention of Pollution of the Sea by Oil, 1954, adopted by Conference of Contracting Governments at London, April 11, 1962, (1966), 2 U.S.T. 1523, T.I.A.S. No. 6109.

[36] International Convention on Civil Liability for Oil Pollution Damage of 1969, 9 **International Legal Materials**, 45, 1970.

[37] All dollar equivalents are based on the official exchange rates following devaluation, figures obtained from State Department 7/27/73.

[38] S. 841, "A Bill to Implement the International Convention on Civil Liability for Oil Pollution Damage and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage," p. 3.

[39] Torrey Canyon figures from Douglas Meiklejohn, "Liability for Oil Pollution Cleanup and the Water Quality Improvement Act of 1970," 55 **Cornell Law Review**, (1970), p. 982.

[40] International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 11 **International Legal Materials**, 284, 1972.

OIL: ITS PROPERTIES AND ENVIRONMENTAL EFFECTS

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Petroleum is not a single or specific organic substance. There are different types of crude oils, which have widely different properties. At least a limited knowledge of these properties is necessary for an understanding of their differential effects on the environment.

Crude oil is a mixture of hydrocarbons and organic compounds containing sulphur, nitrogen and oxygen.

The main classes of **hydrocarbons** contained in crude oil are as follows:

Alkanes, or paraffins, which are saturated chains. An example is hexane.

Cycloalkanes, or napthenes, which are saturated cyclic compounds. An example is cyclohexane.

Aromatics which are unsaturated compounds containing the benzene ring.

Also present in oil are:

Alkenes, or olefins, which are unsaturated chains. They are produced in refining processes.

Napthenic Acids which are alicyclic compounds associated with carboxylic acid groups.

Sulphur which is present in the free state or as hydrogen sulfide or other compounds.

Oxygen and **nitrogen** which are constituents of organic compounds (Baker, 1970).

Trace metals such as vanadium are also present.

The origin of a given sample of oil can be determined by the proportion of different hydrocarbons and trace elements in the oil. Many "fingerprinting" techniques have been developed (Miller, 1973; Coakley, 1973), mostly to identify unknown sources of oil pollution.

Generally, the proportion of different hydrocarbons in oil affects its specific gravity, while the proportion of non-hydrocarbon residues affects its boiling point. The higher the proportion of non-hydrocarbon residue, the higher the boiling point and the larger the average molecular size.

When oil is refined, it is divided into different fractions which have different boiling temperatures and different average molecular sizes. Table 1 illustrates this for some "cuts" of oil:

TABLE 1

Cut	Approximate boiling range	Approximate molecular size
Refinery Gases	up to 25 C	$C_3 - C_4$
Gasoline*	40 −150 C	$C_4 - C_{10}$
Naphtha	150−200 C	$C_{10} - C_{12}$
Kerosene	200−300 C	$C_{12} - C_{16}$
Gas oils	300−400 C	$C_{16} - C_{25}$
Residual oil	above 400 C	above C_{25}

*Gasoline here refers to a basic cut of crude oil. The name is also used as a synonym of petrol and in that case refers to the basic cut after further treatment (Bezzart, 1967).

NOTE: Molecular size is determined by the number of carbon atoms (c).

The **toxicity** of oil, and therefore its effect on the environment, is dependent on the proportion of various hydrocarbons in the material, the molecular size, and the boiling point. Toxicity generally increases along the series of hydrocarbons listed above, from the alkanes to the aromatics; since paraffins and napthenes are both saturated molecules, they are less chemically reactive than the unsaturated aromatics. As the aromatic content of an oil is increased, its toxicity is also generally increased. However, the smaller molecules of each type of hydrocarbon in the series have a smaller proportion of non-hydrocarbon residues, a lower boiling point, a lower viscosity, and, therefore, are more toxic than the larger molecules. The toxicity of small, low-boiling point molecules may be due to its availability to plant and animal tissues. Large molecules may just be too large to penetrate plant tissue (Baker, 1970).

The toxicity of oil spilled at sea and its actual effect on the environment is dependent on four main factors. First, the *type* of oil is important. Oil can be distinguished according to its country of origin; some have higher proportions of lighter "cuts" with lower boiling ranges, or higher proportions of aromatics. In short, the origin of the oil spilled in the first place determines which toxic elements are entering the marine ecosystem and in what proportions. Second, the *location* of the spill is important. The location determines which plants and animals will be affected and to what magnitude. If a spill is close to shore, the chance for dispersal and dilution of oil is low. An example was the wreck of the *Tampico Maru* in a cove in Baja California, Mexico in 1957. The ship itself blocked the entrance to the cove. All fractions of the oil were immediately available to the flora and fauna, and there was widespread destruction. When oil is spilled far from shore, however, it is subject to various physical forces which act on the oil to change its properties, its inherent toxic qualities, and its ultimate effects on the environment. Third, *the season* in which the spill occurs is important. Immature forms of certain species of plants and animals are generally more susceptible to toxic substances than adults. If oil is spilled when there is a high density of immature forms such as in the spring, there may be a greater mortality. Fourth, the *concentration* of oil in the water is important. The concentration is determined by the amount of oil which was spilled and by the degree of dispersal which occurs.

The dispersal of oil in water is affected by wind, temperature and currents, as well as by its own specific gravity, viscosity and surface tension. Most oil will spread over the water until it is only one molecule thick. These thin layers of oil can be seen in sunlight as colorful rings called Newton Rings (ZoBell, 1962). Most oil is more viscous than this, and the slick takes the form of a lens, with a dark thick core in the center surrounded by a thinner irridescent layer (IMCO, 1972). The size of the slick will increase until a significant proportion of the lighter fractions evaporate, dissolve, oxidize, emulsify, or become utilized by micro-organisms.

Evaporation is dependent on the nature of the oil itself; oils with a high proportion of the lighter, more volatile fractions will obviously evaporate more readily than heavy, viscous oils. Evaporation is also dependent on wind and wave action. A film of oil tends to decrease wave action and the amount of surface area of oil exposed to the air. Thus, unless the wind is strong enough, the evaporative potential of the oil will also be decreased. High temperature, especially in conjunction with high winds, also increases the evaporative potential of oil. In a situation where an oil high in light, volatile fractions is spilled far off shore during high seas, heavy winds and high temperature, a significant proportion of the oil would evaporate before reaching the beach.

Only a small proportion of oil will dissolve in sea water, and this consists primarily, as in evaporation, of the lighter fractions of low molecular weight. These are also the more toxic fractions (IMCO, 1973). Dissolution is also aided by wave action and increased temperatures. It has been theorized that at a finite solubility of 1 ppm, all of the oil carried in the *Torrey Canyon* could have been dissolved in a 20-mile-square, 500-foot-deep area of sea (Dean, 1968).

Autoxidation is a process which occurs in oil when a sufficient amount of oxygen is present. Again, this method of dispersal is limited to the lighter, high boiling point fractions which do not have associated non-hydrocarbon residues. Autoxidation is also limited to areas of open, well-mixed, air-saturated water. Given an average BOD of 3.3 (B.O.D., the Biological Oxygen Demand, is the amount of oxygen necessary to oxidize 1.0 mg of a substance to carbon dioxide and water), it would take 3,300,000 mg of oxygen to oxidize one liter of heavy mineral oil. Thus, the complete oxidation of 1 liter of oil would deplete the oxygen from 400,000 liters of air-saturated sea water (ZoBell, 1962).

Some crude oils, when agitated by wind and waves, will form water in oil emulsions. These emulsions form thick gell-like blobs which are often known as "chocolate mousse." Other oils break up into tiny droplets which disperse in the water. After evaporation and polymerization, these oil-in-water emulsions become heavy and viscous and produce mobile tarry lumps. These tarry lumps tend to absorb floating debris, clay, silt, diatomoceous earth and other particulates. Some of the tar lumps are carried long distances by waves and tidal currents. Those which become heavy enough to sink are carried by density currents along the sea floor. The oil which reaches the beach in this form is often covered by sand and debris and is the familiar form of "oil pollution."

Oil can be utilized as an energy source by various types of microorganisms including bacteria, yeasts and molds. Bacteria, however, are the most prevalent microbes in the marine environment which attack hydrocarbons. Different species are highly specific as to which hydrocarbon fractions they are able to utilize. Certain species attack only the small-molecule members of a series. Other organisms may attack only saturated, cyclic compounds, the napthenes. Some species are polyphagous and are able to utilize paraffins, olefins, napthenes and aromatics (ZoBell, 1962). Blumer (1971) reported that it is the less toxic, saturated hydrocarbons which are attacked more readily than the more toxic aromatics. Moreover, he stated that the byproducts formed during biodegradation may be more toxic than the original hydrocarbons. There is contradictory evidence to Blumer's contentions. ZoBell (1971) found that bacteria can in "most marine environments" bring about the degradation of carcinogenic hydrocarbons.

The rate of hydrocarbon oxidation by bacteria is controlled by a number of factors including the water temperature; the availability of oxygen and oxygen donors such as nitrates and phosphates; the availability of nutrients such as phosphorous; and, since the amount of oil biodegraded is related to the surface area, by the degree of dispersion of the oil. The maximum rate of microbial oxidation occurs between 25 and 37°C in air-saturated water. Many species of bacteria can utilize nitrates or phosphates as sources of oxygen. It takes approximately 4 mg of nitrate to completely oxidize 1 mg of mineral oil. There is rarely more than .1 mg of nitrate per liter in sea water (ZoBell, 1962). Reisfeld, Rosenberg and Gutnick (1972), isolated eight pure cultures of bacteria which degrade crude oil and found that even in pure sea water, their cultures were completely dependent on exogenous sources of nitrates and phosphates as oxygen donors.

The dispersal of the oil-in-water is another crucial factor for biodegradation. ZoBell (1962) reports that hydrocarbons will not be attacked at all unless the molecules are in contact with water. The factors governing the dispersal of oil have already been discussed.

It is clear from this discussion of biodegradation that the subject is complex. Only mixed cultures of bacteria which can attack the various fractions of the oil present, as well as the byproducts formed during oxidation, can do a significant job of dispersing an oil slick. Furthermore, temperature, oxygen and solubility are limiting factors. Nevertheless, it has been estimated that, under optimum conditions, oil can be oxidized by bacteria in the sea at a rate in the range of 36–350 g/m^3/year (ZoBell, 1962).

An understanding of the way in which an oil slick is dispersed is crucial to an understanding of the environmental effects of oil spills. The toxicity of oil depends on its concentration as well as its composition, and the nature of dispersal of an oil slick will affect both.

Toxicological studies usually measure the LD$_{50}$, or the lethal dose which will kill 50 per cent of the test organisms. There are several different routes by which the toxicant can be administered to an organism: through its respiratory mechanism, through its digestive tract or through its protective covering. In the marine environment, it may not always be clear through which route a lethal dose of oil acted. As was discussed above, it also may not be clear exactly which fraction of oil was responsible for a detrimental environmental effect. The subject is further complicated in that some organisms are more susceptible than others to the same agent. The size and stage of life may also be important in toxicological studies. An organism may be more sensitive to a toxicant in its early life stage.

The ecological effects of oil spills have been studied in two ways. They have been studied in the field, in order to assess the actual damage from oil spill disasters, and in the laboratory, in order to determine the biological mechanisms responsible for that damage.

Oil can be toxic to plants either by physically or chemically interfering with life processes. Oil may reduce transpiration and respiration rates by physically blocking stomata and intercellular spaces. It may interfere with photosynthesis by acting as a physical barrier to gaseous exchange or by absorbing certain wavelengths of light which would ordinarily be used for photosynthesis. It may penetrate the phloem and xylem and interfere with transport mechanisms within vascular plants. Oil may also prevent germination and growth by coating a seed and interfering with oxygen and water intake (Baker, 1970). The physical effects of oil on plants are probably caused more often by the heavier, more viscous fractions of oil than by the lighter, more reactive fractions.

Chemical effects on plants usually require an initial penetration of the oil into the plant tissue. The damage then takes place by damage to cell tissue or by interference with the basic life processes of respiration, photosynthesis, transpiration, and reproduction. Van Overbeek and Blondeau (1954) found that hydrocarbons can dissolve plasma membranes by displacing fatty molecules. The result was leakage of cell sap from the cells into intercellular spaces (Baker, 1970). Interference with respiration may also occur due to damage to the membrane surrounding the mitochondria. This would interfere with the ATP-ADP processes of sugar oxidation and storage. Photosynthesis can also be inhibited by the application of oil. This may be due to the destruction of chloroplasts by hydrocarbons. (Baker, 1970) Germination of seeds may also be impeded by the penetration of oil into the seed. (Cornell, 1969)

Oil spilled at sea may affect several plant communities: phytoplankton, floating plants, rooted aquatic plants and salt marsh vegetation. The effects of oil on phytoplankton vary from stimulation of growth to complete suppression of growth, depending upon the species. Kauss *et al.* (1973) found that *Anabaena flosaquae* and *Ankistrodesmus convolutus*, both freshwater algae, had increases in their populations after exposure to crude oil. Kauss suggested that these algae were able to utilize some of the water soluble components of the oil as a carbon source. There are other investigators who believe that this is a viable explanation for increased algae growth after an oil spill. A study by Masters and Zojic was reported in the IMCO (1973) study in which two species of *Chlorella*, *C. vulgaris* and *C. ellipsoidia*, showed increased growth in a medium containing 0.1% n-heptadecane. Further study revealed that two species of *Scenedesmus*, *S. brevicauda* and *S. quadricauda*, were able to utilize n-alkanes. Each species, however, was highly selective as to the chain length they were able to utilize. Other mechanisms may be responsible for increases in phytoplankton growth — mainly the destruction of grazing zooplankton.

Some species of freshwater algae studied by Kauss *et al.* (1973) were either tolerant to or unaffected by oil. The tolerant species included *Ankistrodesmus falcatus var. aricularis* and *Fragillaria visescens*.

Other species, notably *Dinobryon sertularia* and *Peridinium sp.*, were definitely inhibited by the presence of oil (Kauss, 1973). Mironov (1969), as cited by Monaghan and Koons (1973), reported that low concentrations of crude oil decreased the rate of photosynthesis of phytoplankton. Since most of the world's oxygen is supplied by phytoplankton, a decrease in its rate of photosynthesis could have serious effects on all living things. Certainly, more research is needed in this crucial area.

The variability shown in these laboratory experiments is duplicated in field investigations of major oil spills. A report of the *Torrey Canyon* disaster by Smith (1968) indicated that there was mortality of phytoplankton following the spill. A report by Abbot and Straughan (1969), on the other hand, revealed that the blowout in Santa Barbara did not significantly affect phytoplankton.

Whether or not damage to a phytoplankton population would be short-term and local or long-term and widespread is open to conjecture. Not enough is known about the population dynamics of marine phytoplankton to predict ultimate effects of perturbation on these populations or on the species which depend on them.

The effect of oil on benthic and littoral plants also seems to be species specific. Generally, brown algae *(Phaeophyceae)* are reported to be more resistant than either red *(Rhodophyceae)* or green *(Chlorophyceae)* algae (Nelson-Smith, 1968).

The *Tampico Maru* was wrecked along a bed of kelp, *Macrocystis pyrifera.* Although most of the organisms in the cove were killed in this disaster, the kelp beds flourished. This was attributed to the destruction of organisms which graze on the kelp beds (ZoBell, 1962). In laboratory experiments, on the other hand, the photosynthesis of kelp was almost completely inhibited by diesel oil (the same type lost by the *Tampico Maru*). The mucilaginous outer layers of the kelp were apparently able to protect it from the toxic fractions of the oil. In a report of the *Torrey Canyon* disaster, Bellamy *et al.* (1967) were able to show that most of the effects to the attached macrophytes were due to an altering of the balance in the littoral ecosystem due to the destruction of grazing organisms.

The effects of oil on salt marsh flora was discussed in a series of articles by Baker (1971). The sensitivity of salt marsh plants to oil is species specific. The duration of the effort is mainly due to the type of oil and the season. Most damage is done in the spring when injury to flowers or seedlings eliminates the year's crop. Baker reports that complete recovery from one oiling can take two years. More lasting effects result from the successive oilings of chronic pollution.

The effect of oil on animal communities is, as with plant communities, dependent on the type of oil spilled, the circumstances under which the oil was spilled and the actual animal communities affected. Most animals are capable of locomotion, and, if alarmed, should be able to avoid an oil spill. This is not true for certain species of diving birds which will dive when alarmed or because the oil resembles food and thus are more likely to come in contact with an oil slick. This also applies to most zooplankton and mollusks which are very limited in the distance they can travel. The zooplankton include a host of microscopic invertebrates as well as the eggs and larvae of larger vertebrates and invertebrates. The composition of the zooplankton is constantly changing from season to season and from place to place. This makes it extremely difficult to assess the damage done to a community of zooplankton. There are few actual reports on the effect of an oil spill disaster on a zooplankton population. After the Santa Barbara blowout, a near normal distribution and abundance of fish eggs and larvae and of larger zooplankton was found in the vicinity of the spill (Holmes, 1968).

Studies of the effects of oil on individual species, however, are not as encouraging. A study on lobster larvae by Wells (1972) indicated that at long exposures to concentrations of oil above 1 ppm and below 10 ppm development was abnormal and slow. In a study on copepods, Mironov, as cited in the IMCO study (1973) found that there was high mortality at concentrations of 10 ppm. Studies on the effects on herring fry also showed high mortality (Kuhnhold as cited in IMCO, 1973). The presence of oil may also affect behavior. Rice (1973) found that pink salmon fry actively avoided sub-lethal concentrations of crude oil. He theorized that chronic pollution of coastal waters would force migrating salmon into offshore waters where the food supply is insufficient.

The harmful effects of oil spills on fish fauna seems to be most severe on the eggs and larvae which are extremely sensitive to high boiling point hydrocarbons. There have been no reports of massive fish kills after major oil spill disasters, although most laboratory evidence indicates that fish are susceptible to the toxic effects of oil (Tagatz, 1961) and to many of the chemical dispersants used to clean up after oil spills (Swedmark *et al.* 1971).

Many of the more recently developed chemicals, however, are considerably less toxic than the "first generation" of dispersants (J. Wardley Smith, personal communication). Since fish are mobile and have a demonstrated ability to avoid oil spills (Rice, 1973), the effects on fish populations are more likely to be due to the effects on the food supply. The tainting of fish flesh is an important problem for commercial species, but little testing has been done by health authorities (Blumer, 1971).

The effects of oil on commercial shellfish and other invertebrates of the benthic and intertidal zone have been more completely documented than the effects of fin fish. After the *Tampico Maru* was wrecked in Baja California, there were massive kills of abalone, lobster, sea urchins, barnacles, sea stars, mussels and clams (ZoBell, 1972). Chan (1973) reports that after the San Francisco oil spill of 1971, approximately 4.2 million barnacles, limpets, and other organisms were smothered and killed by oil. He found that two years later recolonization was taking place. Simpson (1968) reports that there have been no such massive kills around the British Isles, although sufficient tainting of the commercial species did occur which rendered them unsaleable. Blumer (1971) reported that the tainting of shellfish by oil was irreversible. When tainted shellfish were transplanted to clean water, hydrocarbons were not removed from the body tissues. There has been evidence both to support and to contradict Blumer's statement. In studies conducted at Mississippi State University, oysters were exposed to 300 ppm of Empire Crude Oil for 96 hours. They were then placed in clean water. The oysters did not lose their taint for as long as nine weeks following the spill. This was measured by a taste test, supposedly one of the most sensitive methods for discerning oil in shellfish tissue (Royal Nadeau, personal communication). Anderson (1973) reported that oysters did depurate accumulated hydrocarbons from their tissues. He agreed with Blumer that the aromatics were accumulated more rapidly and removed less rapidly than saturated hydrocarbons, but he reported a lack of detectable levels (by infrared spectrophotometric analysis) of either after 52 days. This has serious consequences for local fishermen. Blumer also stated that contaminated sediments are a source for further tainting of future generations of shellfish. Furthermore, he found that oil interferes with pheremones, the chemicals by which animals communicate, by either interfering with their reception or by mimicking them directly. A case in point is the lobster which is actually attracted to toxic levels of oil pollution due to its similarity to its own hydrocarbon sexual attractant.

The damage to bird populations is the most direct and obvious effect of oil spills. After the San Francisco oil spill, 10,000 birds were found dead. Between 1951 and 1952, approximately 100,000 oiled birds were counted on the coast of Great Britain and about 250,000 ducks and other waterfowl were reported to be killed in one oil spill in the North Sea (ZoBell 1962). A puffin population on Annet off Sicily which had once numbered in the hundreds of thousands has been affected by oil spills since 1907 and now barely numbers one hundred (Bourne, 1968). Although other factors such as DDT and PCB's may contribute to population reductions, oil seems to be the main causative factor in this particular case. The results of the Santa Barbara blowout are familiar. The types of birds most affected by oil spills include auks, auklets, dovekies, eiders or sea ducks, gannets, grebes, guillemots, gulls, loons, murrelets, murres, pelicans, petrels, puffins, razorbills, scoups, scoters, and swans (ZoBell, 1962). Penguins are also severely affected. The Jackass penguin population of South Africa is approaching extinction due to oil pollution (IMCO, 1973). The oil causes the bird's feathers to stick together, reducing insulation capacity and the metabolic rate is increased in response to the cold. When the bird's fat stores are exhausted, it is unable to expend extra energy to feed and dies from the combined effects of starvation, exposure and the added effects of oil ingested during preening. If it does survive, it is likely to remain in a weakened condition which reduces its fertility. Furthermore, if oil gets on the eggs which are laid, respiration through the shell is blocked and further mortality results (Bourne, 1968).

The effects of oil spills to the health of the human population is an area in which little research has been conducted. The effects can be either direct, through skin contact, or indirect, through contaminated fish or shellfish. Blumer (1971) contended that the concentration of high boiling point, aromatic hydrocarbons in the tar lumps found on beaches increases the sunbather's exposure to carcinogenic material by direct skin contact. He further contends that carcinogens can be passed along the food chain and can be ingested by man in tainted fin fish and shellfish.

The cleanup measures which have traditionally been used after an oil spill include the use of chemical detergents and dispersants, burning, physical sinking, mechanical containment, and bacterial degradation. Most of these methods have been ineffective, and some have caused even more extensive ecological damage than oil itself.

Chemical detergents and dispersants are often toxic in and of themselves, and research is presently being conducted to develop non-toxic dispersants (Canevari, 1973). Blumer (1971) contends that dispersants simply make the oil more available to the ecosystem by making it more soluble. Burning is difficult to promote and control in stormy seas, a condition under which most oil spills occur. It has not often been used as a remedy.

Physical sinking is also not a recommended method of oil removal in most cases. We know little about the long term effects of sinking in extremely deep seas, and in littoral communities the effects on shellfish are definitely detrimental. Furthermore, biological degradation requires an excessive amount of oxygen; in anaerobic environments the rate would be severely decreased.

Mechanical containment seems to be an almost ideal method, especially if the spilled oil could be recovered. There is presently a great deal of research being conducted on improving the design of booms and collection devices. (See section on Control Technology, Proc. Joint Conf. Prevention and Control of Oil Spills, EPA, API, USCG, 1973) Seeding of mixed bacteria cultures to promote biological degradation also seems like a promising measure, if oxygen depletion can be avoided. This may be accomplished by enriching the water with oxygen donors such as nitrates or phosphates or with other vital nutrients.

One point is clear in this review: our ability to assess the ecological damage due to spills is presently inadequate. Gaps and inconsistencies in the present research make it difficult to determine the overall effect of oil on the environment.

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